NATURE

No. 4522 SATURDAY, JUNE 30, 1956 Vol. 177

CONTENTS

Page

Academic Freedom 1189

Freedom in American Universities. By R. Brightman 1190
Physics of Stellar Atmospheres. By Dr. Arthur Beer 1191
Services' Text-book of Radio. By C. R. Stoner 1192
Optical Investigation of Diamond Surfaces. By Dr. J. W. Mitchell, F.R.S. 1193

The Atomic Energy Research Establishment : the First Ten Years. By Dr. A. H. S. Matterson 1195
Propulsion Problems in High-speed Flight. By H. Constant, C.B.E., F.R.S. 1196
Why Laboratory Animals Die. By Dr. W. Lane-Petter 1198
Food Technology and Nutrition 1199
Science House, Pakistan. By Sir George Allen, C.B.E. 1201

Obituaries :
Dr. Walter Sydney Adams, For.Mem.R.S. By Prof. F. J. M. Stratton, O.B.E., F.R.S. 1201
Mr. P. W. Wood. By Ebenezer Cunningham 1202
Dr. M. A. Whiteley, O.B.E. By Dr. L. N. Owen 1202

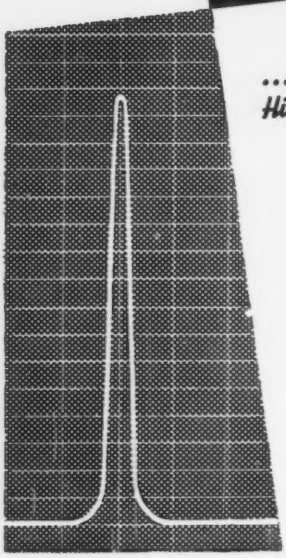
News and Views 1203

Improvements in Seismic Prospecting 1209
Electrical Equipment of Aircraft 1210
Marine Biology : Symposium at the Scripps Institution. By Prof. C. M. Yonge, F.R.S. 1212
Scientific Humanism 1212
Ecological Analysis of the Interbreeding of Crested Titmice in Texas 1213
Stanford Research Institute, California : Report for 1955 1213
Future Numbers of University Students in Britain 1214
Mating Systems of Fungi 1215
Researches in the Arctic Ocean 1215
Anaerobic Deamination of D-Glucosamine by Bacterial and Brain Extracts. By Dr. P. Faulkner and Prof. J. H. Quastel, F.R.S. 1216
Factors affecting the Vernal Phytoplankton Outburst in the English Channel. By Dr. W. R. G. Atkins, C.B.E., O.B.E. (Mil.), F.R.S., and Pamela G. Jenkins 1218
Electromagnetic Phenomena of Natural Origin in the 1·0–150 c./s. Band. By Dr. Philip A. Goldberg 1219

Letters to the Editors :
An Investigation of Monochromatic Radio Emission of Deuterium from the Galaxy.—G. J. Stanley and R. Price . 1221
A Simple Method of studying Winds in the Ionosphere by using a Continuous-wave Radio.—Dr. B. Ramachandra Rao and D. Satyanarayana Murty 1222
Sudden Decrease in Low-frequency Atmospheric Noise during the Cosmic-Radiation Storm of February 23.—C. A. McKerrow 1223
Termination of Chains in Vinyl Polymerization by Metal Salts.—Dr. E. Collinson and Prof. F. S. Dainton . . 1124
Change of Hardness in Steel due to Hydrogen.—H. G. Vaughan and M. E. de Morton 1225
Separation of Hydrocarbon Isomers by Thermal Diffusion.—Dr. C. J. Danby, J. D. Lambert and C. M. Mitchell . 1225
Emission of Photo Radiations by the Impact of Positive Ions of Helium on Nickel.—Prof. Rafi M. Chaudhri, Mustafa Yar Khan and Abdul Latif Taseer 1226
Viscosity of Liquids and Ultrasonic Studies.—Prof. A. K. Dutta, B. C. Ray and H. K. Rout 1227
Indentation Hardness of Diamond.—Dr. P. Grodzinski 1228
A New Apparatus for Cathodic Sputtering.—L. Holland 1229
Radioactivation Analysis of Phosphorus in Iodine.—J. A. James and D. H. Richards 1230
Crystal Structure of *p*-Chlorbenzene Iododichloride.—D. A. Bekoe and Ralph Hulme 1230
Ultrasonic Relaxation in Unsaturated Aldehydes.—M. S. de Groot and John Lamb 1231
Coupled Oxidation of Keto-Acids with Glutathione.—D. Cavallini, G. F. Azzone and F. Stirpe 1232
Anticoagulant Specificity and Physiologically Inactive Beta-Prothromboplastin.—Dr. P. Fantl and Dr. R. J. Sawers 1233
Action of Chlorpromazine on Oxidative Phosphorylation of Liver and Brain Mitochondria.—Magdalena Berger, H. J. Strecker and Prof. H. Waelsch 1234
Effects of Pituitary Growth Hormone on the Insulin and Hyperglycæmic-glycogenolytic Factor extractable from the Pancreas of Obese-Hyperglycæmic Mice.—Dr. D. W. Clarke, Dr. G. A. Wrenshall and Dr. J. Mayer . . 1235
Mechanism of Anorexia in Vitamin-deficient Hyperphagic Animals.—Dr. L. R. C. Agnew and Jean Mayer . . 1235
Lactose as a Lipotropic Agent.—Prof. D. P. Sadhu 1236
Utilization of the Carboxyl Carbon of L-Phenylalanine for the Synthesis of the Amino-acids of Silk by *Bombyx mori*. S. Bricteux-Grégoire, W. G. Verly and Prof. M. Florkin 1237
Tremor produced by Drugs.—Dr. Guy M. Everett 1238
Auto-oscillations in Extracted Muscle Fibre Systems.—M. C. Goodall; Dr. L. Lorand and C. Moos . . . 1238
Plasma Factor(s) influencing Red Cell Production.—L. O. Jacobson, L. Plzak, W. Fried and E. Goldwasser . . 1240
Embryology, Epigenetics and Biogenetics.—Dr. William P. D. Wightman ; Prof. C. H. Waddington, F.R.S. . 1240
Effect of Some White Pigments on the Actinic Degradation of Cotton.—W. R. Hindson and P. G. Kelly . . 1241
A Gas Phase in Viable Fungal Spores.—Prof. C. T. Ingold 1242
Septate Fibres in Angiosperms and their Length.—K. A. Chowdhury, S. K. Purkayastha, S. S. Ghosh and J. S. Sond 1243
Effect of Hormone Herbicides on the Growth of *Rhizobium trifolii*.—Dr. Wm. W. Fletcher 1244
Growth of Lettuce Seedlings.—Winifred M. Dullforce 1244
Soil Thermometers.—Z. S. Garvitch and M. C. Probine 1245
Periodicity of the Laminariaceae around Scotland.—F. T. Walker 1246
A Marlin in Angola, with a Note on *Makaira herschelii* (Gray), 1838.—Prof. J. L. B. Smith 1246
Death of Flamingoes in the Carmargue.—John Hillaby 1247

Recent Scientific and Technical Books . . . . . Supp. viii

BALZERS



...means Research in High Vacuum Process

Monochrom. Interference Filters, Achromatic Beam Splitters, Dichroic Beam Splitters, Heat Deflectors, Cold Mirrors, Front-Surface Mirrors, Cut-Off Filters, Anti-Reflection Coatings and many other Thin Films

Write for Technical Circulars

GERAETEBAU-ANSTALT · BALZERS · F. LIECHTENSTEIN · SWISS CUSTOMS AREA

A recent publication

BIOMATHEMATICS

CEDRIC A. B. SMITH

M.A., Ph.D.

Lecturer in Statistical Genetics, University College London

The need for mathematics in biology is continually increasing. This important book is intended as a reference book for post-graduates in biology, and it also provides a readable introduction for the early stages of a biological course. The author's patient skill in exposition removes many difficulties of the more advanced processes.

"This is an excellent book . . . very strongly recommended to anyone requiring either a systematic course of reading in mathematics at this (student's) level, or a reference book, and its use should by no means be restricted to those whose main interest is in biology." D. R. COX, in The Journal of the Royal Statistical Society.

712 pages. Third Edition. Price 80s. net

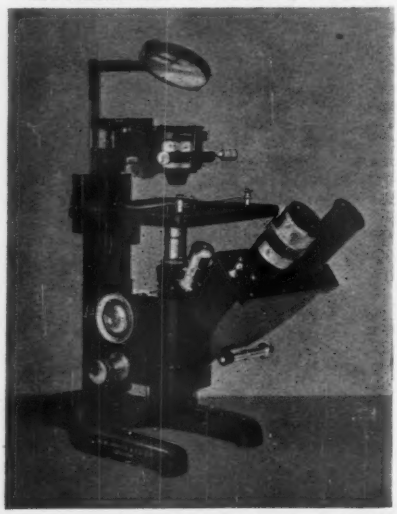
CHARLES GRIFFIN & COMPANY LTD

Established 1820

42 DRURY LANE LONDON W.C.2

The Hall-mark of a PRIOR Precision-built Microscope

INVERTED MICROSCOPE



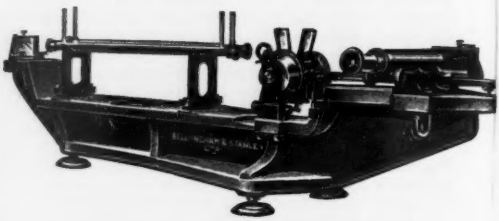
W. R. PRIOR & CO. LTD.

NORTHGATE END, BISHOP'S STORTFORD, HERTS.

PRECISION BS INSTRUMENTS

Jamin Refractometer

for liquids or gases



Average accuracy in measurement of refractive index is approximately 0.000001 for gases and 0.000002 for liquids.

The elimination of all spring adjustment to the mirrors results in great stability and freedom from vibration. Worm wheel gearing actuates the compensator. Tubes up to 50 cm. length can be used.

Bellingham & Stanley Ltd.

DEPT. N, 71 HORNSEY RISE, LONDON, N.19

PHONE: ARCHWAY 2270

ACADEMIC FREEDOM

IN his recent book, "Academic Freedom in Our Time"* (see also p. 1190), Prof. R. M. MacIver makes a number of suggestions for the defence of academic freedom which are intended for American readers. They require re-thinking and modification before they could be applied in the British Commonwealth; but there is much in the book that is of general interest and highly pertinent to issues which have recently been raised in the Commonwealth. His statement of the intra-mural and extra-mural rights which arise from consideration of the scholar's function and consequent service to society have, however, a general validity and apply in Britain and elsewhere in the Commonwealth as much as in the United States. Three are intra-mural: the right professionally to decide matters calling for professional competence; the right to a status commensurate to his responsibility and consonant with his high service to society and civilization; and the right to conditions of tenure that secure him against dismissal or professional penalization save for professional incompetence or conduct that in the judgment of his professional colleagues renders him unfit to be a faculty member. Extra-murally, there are the right to a private life free from controls that are not imposed on other citizens, and the right to exercise the same political and civil liberties that are enjoyed by other citizens.

The validity of Prof. MacIver's general thesis and the application of these conditions were amply demonstrated by papers presented last August at a symposium on the place of the Australian university in the community (see *Nature*, June 9, p. 1071), and by the difficulties in which the University of Tasmania has found itself involved in recent years, and which have not been removed by the report of the Royal Commission of inquiry set up last year. It is abundantly clear that the main trouble and major difficulties in Australia arise from the lack of a clear and widespread public understanding of the nature and purpose of a university, and perhaps especially from the absence of any considerable nucleus among politicians and industrialists of those who have themselves passed through a university and acquired a respect for it and understanding of the conditions essential for its effective work. By and large, there is not that mutual understanding and respect between the university administrator and the Government, whether Minister or Civil servant, which, as American observers have been quick to note, is one fundamental factor in the smooth functioning of the University Grants Committee in Britain.

In the symposium just noted, Prof. A. Boyce Gibson suggested that in certain respects the Australian universities stand nearer those of the United States than those of Great Britain, and for that reason alone it might well be that Prof. MacIver's book on the American universities, and also a related volume by Prof. R. Hofstadter and W. P. Metzger entitled "The Development of Academic Freedom in the United States"* (see also p. 1190), may be more effective in breaking down the parochialism which is one of the weaknesses of Australian universities, as both Prof. D. M. Myers and Prof. J. B. Polya have emphasized, than any corresponding volume from British sources. Moreover, by displaying the problem of academic freedom in its widest context, they should certainly promote the public understanding of the issues that is an essential step towards the resolution of these difficulties in Australia. Nor is Australia the only place in the British Commonwealth where excessive concern with the utilitarian or vocational aspect of a university to the neglect of its primary purpose is endangering the work of a university or the maintenance of standards.

Prof. MacIver points out specifically the danger to university work and standards inherent in any unqualified assertion that its business is to prepare the student for his place in society. In a society that practises racial segregation, for example, a university which accepts this view will tend to inculcate in the student the ideas of segregation, with the consequence that scientific knowledge regarding racial qualities would be rejected or distorted, and any university administrator or teacher who ventured to contradict the prevalent myths would be liable to be dismissed. The bearing of this observation on the situation in South Africa is obvious, and Prof. MacIver's volume should bring further support to the Universities of the Witwatersrand and of Cape Town in their stand against the policy of the Government.

It is no less relevant to the issues which have recently come to the fore at the new inter-racial University College of Rhodesia and Nyasaland. The College, which is to open its doors in March 1957—a year later than was originally hoped—will have both African and European students and, as now planned, the University College represents a compromise between the recommendations of the Carr–Saunders Commission and the original plans of the inaugural board of the Rhodesian University. Although it is a multi-racial institution, the two groups of students are to live in different hostels, but they will mix without distinction in their academic work, in sport and socially.

Concern has, however, been expressed in the House of Commons about these arrangements, the pertinent question being asked whether it was a contribution to multi-racial policy to separate the races in an educational institution like this; and on May 8 Lord Lucas asked the Government whether, in view of the Government's financial contribution to the establishment of the College, it is satisfied that the proposed residential arrangements are consistent with the

* Academic Freedom in Our Time. By Prof. Robert M. MacIver. Pp. xiv+329. (New York: Columbia Univ. Press; London: Oxford Univ. Press, 1955.) 32*s*. net.

* The Development of Academic Freedom in the United States. By Prof. Richard Hofstadter and Walter P. Metzger. Pp. xvi+527. (New York: Columbia Univ. Press; London: Oxford Univ. Press, 1955.) 45*s*. net.

principle of a multi-racial university. The Secretary of State for Commonwealth Relations, the Earl of Home, in his reply, pointed out that the Carr–Saunders Commission considered that separate hostels would be in accordance with the multi-racial principle. He believes that the University College should first concentrate on establishing conditions which will attract both Europeans and Africans to the College. When that is secured, many other developments will follow which we cannot as yet foresee.

One of the most satisfactory features of the Government's reply is not the reassurance that the proposed residential arrangements are consistent with a multi-racial institution, but the clear understanding of the nature of a university institution and deep respect for its autonomy which are implicit in Lord Home's words. It was not merely that he had great confidence in Dr. Walter Adams, principal of the College, as a most enlightened and progressive man; he categorically refused to interfere from Whitehall with people who really know their business, and maintained that it is only right to leave the autonomous Council of the College to make the arrangements most likely to attract both Africans and Europeans to the College.

The question was worth asking for two reasons: as demonstrating the sensitiveness of public opinion in Britain to anything that approaches *apartheid*, and as promoting a clearer understanding of the nature of a university institution. The most disturbing feature of the whole episode is the extent to which the Labour Party, as shown by its criticism, has failed to grasp either the nature of a university or the extent to which the new University College already represents an important advance. As Sir Roy Wellensky, Deputy Prime Minister in the Central African Federation, recently observed, the fact that Africans and white people would be meeting and working at university-level is itself a great step forward. Rhodesians to-day are much more racially minded than people are in Britain, though less so than South Africans, and proposals for still closer relations might well have delayed indefinitely the establishment of the College. Account has to be taken also of the climate of opinion, and Dr. Adams was clearly right in commenting that the policy of separate residences and dining halls is not an issue of principle but a matter of practical convenience.

Dr. Adams added in his letter to Mr. Gaitskell that the Labour Party in Britain has made the task of the College Council doubly difficult by converting into a political and party issue a matter which it was proposing to solve by common sense and experience within the College community. It is fundamental to the success of the College, as he pointed out, that it should attract European students who, unlike the Africans, have the option of going to universities in South Africa. If they or their parents boycott the College, the opportunity for inter-racial co-operation within the common standards of university life would be lost.

What needs to be grasped is that segregation in living quarters is an entirely different matter if the races concerned are already close together than when, as in Rhodesia, they are far apart. In actual fact, the College will bring them a good deal closer than they have ever been before, and the next step should come by growth from within rather than by pressure from without. If the autonomy of the College is respected, we may look forward to the impact on the intellectual level of Rhodesia of its academic staff. There are others on its staff besides Dr. Adams in whose integrity and judgment every confidence can be felt, and they will be helped most in the task of rooting and spreading the academic spirit of Central Africa if they are encouraged to resist pressure from any external source. The attempt to put pressure on them can only defeat the very purpose of the College, and the lack of understanding of the issues which has been shown by political leaders in Britain is a further reason for welcoming any volumes such as those of Prof. MacIver and his colleagues referred to earlier. Such volumes can spread a clearer understanding of the nature of academic freedom, of its importance in any democratic society and of the ways in which it is best defended against the dangers that threaten it in our time.

FREEDOM IN AMERICAN UNIVERSITIES

The Development of Academic Freedom in the United States

By Prof. Richard Hofstadter and Walter P. Metzger. Pp. xvi+527. (New York: Columbia University Press; London: Oxford University Press, 1955.) 45*s*. net.

Academic Freedom in Our Time

By Prof. Robert M. MacIver. Pp. xiv+329. (New York: Columbia University Press; London: Oxford University Press, 1955.) 32*s*. net.

IT is claimed in the preface to the scholarly and massive book on the development of academic freedom in the United States, which Prof. R. Hofstadter and Prof. W. P. Metzger have written under the American Academic Freedom Project, that academic freedom has become one of the central issues of our time. However, apart from Prof. Hofstadter's opening chapter on the European heritage, in which he traces the growth of the idea of toleration, and that in the second part, in which Prof. Metzger analyses with such discernment the German influence on the American universities, the book is concerned almost exclusively with the problem of academic freedom as it has presented itself in the United States from the founding of the first college to the Second World War. That is no less true of the other book, by Prof. R. M. MacIver, the director of the Project, which deals with academic freedom in our time and is also written under the auspices of the Project. Both books contribute to the clearer understanding of the issues at stake and of some of the failures that have surprised or disappointed observers outside the United States; they should help to prevent hasty judgments, as well as indicate where and how help can best be given to American universities in their defence of academic freedom.

without arousing misunderstandings or making their struggle more difficult.

The book by Profs. Hofstadter and Metzger contains much that will be new to those in Britain who are interested in the question of academic freedom, and it has a wide interest in that it gives a very readable account of the development of the universities in the United States. While not purporting to present a systematic account, the book leaves the reader with a very clear understanding of the way universities have developed in the United States, of the differences in their government and organization which sometimes puzzle a British observer and of how American universities have been subjected to influences and pressures from which British universities have largely been free.

It is as a contribution to such understanding that the book is opportune. The immense range and variety of the American scene are displayed with scholarship; but detail is never allowed to become burdensome, and the primary concern with the freedom of members of a faculty is always evident. The issue of freedom for students is scarcely discussed, except where it converges on that of the freedom of the faculty. Prof. Metzger's chapter on the German influence is one of the most interesting and suggestive in the whole volume; it brings out not merely the manner whereby the conception of a university as a research institution contributed to the emergence in the United States of the modern university, in which research took a place along with teaching as a major function, the methods and concepts of science displaced the authority of religion, and in which the academic profession took on, for the first time in full measure, the character, aspirations and standards of a learned profession, but equally it makes clear the selective character of the American reaction to this German influence and especially in the matter of academic freedom. Even more than the influence of Darwinism, which itself contributed to a new conception of academic freedom, is to be noted from this chapter the vitality of the American university which constitutes one of the surest grounds for confidence that it will continue to find means to safeguard its freedom effectively, no matter from what quarter that freedom is threatened.

Prof. MacIver's book is mainly concerned with the past decade and a half and with the dangers arising from heresy hunts and the poisoning of American academic life in the name of security. His introductory chapter is a brilliant exposition of the ultimate issues involved in academic freedom both for the university and for the society of which it is a part. The ability of Americans to grasp what is at stake and to state the issues clearly has been repeatedly demonstrated by observers at the seventh Congress of Universities of the Commonwealth, in volumes such as "Government Assistance to Universities in Great Britain" and in the writings of Prof. Gellhorn, Prof. H. S. Commager and Alan Barth, as well as in earlier volumes of Prof. MacIver. Prof. MacIver's new book continues that tradition. While he describes objectively the nature of the present attack on academic freedom in the United States, the conditions and forces that constitute the real danger, his book is as valuable for the clear picture it gives of the relation between academic freedom and the ultimate function and purpose of a university—for example, its contribution to an understanding of the nature and danger of McCarthyism and the security problem in the United States. It should help to that clear understanding of the nature and function of a university which is no less essential for obtaining that support of public opinion on which it increasingly depends if its work is to be effective and the financial resources drawn increasingly from public funds are to be assured.

What Prof. MacIver brings out especially is that, in standing for academic freedom, the members of a university are doing no more than assert the essential condition under which the university is able to make its great contribution to the moral quality of society and to its spiritual as well as to its material advancement. Society as well as the university suffers if procedures are instituted which seriously affect the integrity of institutions of learning, the intellectual independence of the faculty, or the professional status of their administrators. Moreover, Prof. MacIver explains very clearly but trenchantly exactly how infringements of academic freedom are detrimental to a democratic society and why it is so important that the people as a whole should come to appreciate just what a university is and does; should learn how much of great and lasting worth it contributes to society and how essential it is that its freedom be sustained and its standards advanced; and should recognize how devoted and disinterested the work of the true scholar is.

Prof. MacIver's book is thus of interest to British readers both as a challenge to popular exposition of the meaning of a university and as a contribution to that work of assisting the community in general to regard the university not with suspicion from a distance but from near at hand with affection so that the community itself becomes the guardian of its integrity.

R. BRIGHTMAN

PHYSICS OF STELLAR ATMOSPHERES

Physik der Sternatmosphären, mit besonderer Berücksichtigung der Sonne

Zweite Auflage. Von Prof. A. Unsöld. Pp. ix+866. (Berlin: Springer-Verlag, 1955.) 168 D.M.

THE first edition of Prof. A. Unsöld's book (reviewed in *Nature*, **142**, 975; 1938) was a masterly achievement which presented a large field of astrophysics from a unified point of view, and for many years formed an invaluable foundation for study and research. By combining the results of physics and astrophysics, it played a particularly valuable part in developing the theory of the latter to a state where its consequences could be directly tested by observation.

The enormous advances of the past two decades have transformed the study of stellar atmospheres almost beyond recognition. Various aspects of this progress are excellently dealt with in monographs such as those by S. Chandrasekhar (1950), V. Kourganoff and I. W. Busbridge (1952), R. v. d. R. Woolley and D. W. N. Stibbs (1953), and L. H. Aller (1953 and 1954)—setting the stage for an up-to-date treatment of the field as a whole from a basically physical point of view. The new edition of Unsöld's book is therefore welcome.

The first part, on the general features of stellar atmospheres in thermal equilibrium (105 pp.), discusses the basic radiation laws, observational techniques and results regarding solar and stellar

radiation, and the derivation of mean physical conditions in stellar atmospheres using the Boltzmann and Saha equations. Here there are relatively few changes.

Part 2, on the continuous spectrum and structure of a stellar atmosphere (132 pp.), has been thoroughly rewritten and more than doubled in length. The principal advances in this field have been the development of new methods of solution of the equation of transfer in grey and non-grey atmospheres, the discovery of the overwhelming contribution of the negative hydrogen ion to the continuous opacity in the atmospheres of the Sun and other stars of spectral type F and later, and the development of a more detailed understanding of the effects of convection. In addition, this section contains numerical results of calculations of continuous absorption coefficients and other quantities of great practical value in all research on stellar atmospheres.

Parts 3, 4 and 5 deal with Fraunhofer lines (293 pp.). After a detailed discussion of the practical measurement of line profiles and total intensities, the basic theory of spectral transitions is given, followed by a treatment of re-emission processes (scattering, absorption and non-coherent scattering) and the derivation of the absorption profile in the presence of damping and Doppler effects. The following chapters, on broadening by collision and Stark damping, and on the calculation and measurement of transition probabilities, represent a complete revision in structure and content; an extremely valuable new chapter gives a list of the literature on oscillator strengths up to 1954. In Part 5 (160 pp.) the physical theory is applied to the problem of line formation in an actual stellar atmosphere. After the development of the curve of growth, its application to the "Grobanalyse" determination of the mean temperature, surface gravity and composition of the Sun and of three early-type stars is described in detail. There follow discussions of "Feinanalyse" by the method of model atmospheres, and numerous other topics in the formation of stellar absorption lines are considered. No reference is made to emission lines, although it is likely that these may be formed under certain circumstances in normal stellar atmospheres, without requiring the presence of diluted radiation in extended envelopes—a subject specifically excluded by the author from his terms of reference. Part 5 concludes with a general discussion of the various systems of spectral classification.

Part 6 is devoted to solar physics (183 pp.), and begins by emphasizing the basic importance of hydrodynamics and hydromagnetics in this field. A brief summary of observational techniques is followed by an account of the solar cycle, granulation and the effect of photospheric temperature inhomogeneities on Fraunhofer lines, sunspots, faculæ and the question of a general magnetic field. A discussion of the elements of magneto-hydrodynamics precedes an account of solar and stellar flares. A further chapter deals with eclipses, the chromosphere, corona and prominences; the problem of the heating of the corona is treated in a very stimulating way, and the spectra of prominences and spectroheliogram phenomena are given a detailed interpretation.

Finally, there is an entirely new Part 7 on radio astronomy and cosmic rays (68 pp.). A historical introduction is followed by a summary of the fundamental quantities, the quiet Sun, solar bursts, radiation from the Galaxy and discrete sources, and (briefly) the 21-cm. line. The final chapter of the book deals with the problem of the relationship between radio noise and cosmic radiation.

Three appendixes give physical and astronomical constants, spectroscopic notation, and the properties of exponential integral functions. The very detailed bibliography (56 pp.) lists 1,781 references, compared with 691 in the first edition.

Prof. Unsöld's gifts as an expositor of a field to which he has contributed so much are unique. The treatment of the subject is crystal clear, and the style is not only elegant and very personal, but also so lucid that even a reader with a limited knowledge of German can follow the argument without difficulty. The physically significant points are emphasized throughout, and mathematics for its own sake is avoided; close contact is maintained between theory and observation. The description is everywhere enlivened by the author's individual assessments, and his treatments of subjects on which other monographs are also available—such as solar physics—are so independent and interesting that their value is not at all diminished. On several topics, shortage of space prevents a detailed presentation of the case for certain conclusions that are perhaps controversial, and sometimes the impression is given that the subject is more 'cut and dried' than it really is.

The author's achievement in integrating into a coherent discipline a vast mass of scattered astrophysical research can scarcely be over-estimated. I venture to suggest that it would now be of the utmost value if Prof. Unsöld were to give a similar treatment (in a supplementary volume of about half the present size) of the other very closely related topics that remain, such as emission lines, shell stars, distended envelopes, novæ, variable-star atmospheres, planetary nebulæ, peculiar stars, and the interpretation of molecular spectra. Such a book, together with the present work—both written from a single point of view—would form a completed background to research on the radiation emitted from stars.

The book is very attractively produced and will be of immense value to celestial and other physicists concerned with spectroscopy, photometry, cosmic ray research and ionized gases. It places all astrophysicists incalculably in Prof. Unsöld's debt.

Arthur Beer

SERVICES' TEXT-BOOK OF RADIO

Electronics

By Dr. J. Thomson. Edited by the Technical Staff of *Wireless World*. (The Services' Textbook of Radio, Vol. 3.) Pp. ix+259. (London: H.M Stationery Office, 1955.) 12*s*. 6*d*. net.

THE increase in the importance and complexity of radio in the Armed Services and outside them can be measured by the changes that have taken place in Service literature on the subject. It is a far cry from the original "Admiralty Handbook of Wireless Telegraphy" to the "Services' Textbook of Radio" in seven volumes. The "Admiralty Handbook" was always good value for money to the ordinary purchaser, owing to the conditions of its publication, and this is true of the present "Services' Textbook". As stated in the foreword to the whole series, the books are intended for three distinct classes of readers—the beginner, the technician and the advanced reader. For the benefit of the beginner, more difficult sections (which do not break the

continuity) are specially marked, while there are appendixes giving more advanced mathematical proofs for those able to follow them. In my opinion, this system has worked well in Vol. 3. It is a sign of the times that electrical engineers and technicians are now expected to have some knowledge of the structure of matter. The rapidity with which new materials and methods are being produced makes the acquisition of this knowledge very desirable. In this book, a very readable and accurate (to the best of my rather limited knowledge) introduction to this subject is given.

The author is, of course, an expert on valves and acquainted with recent developments. The chapters on valves are a happy blend of theory and practice, being illustrated by references to modern types, and numerical values are stressed throughout. A suggested explanation is given for the fact that oxide-coated cathodes can be used at high voltages and currents under pulsed conditions. After discussing high-frequency effects in 'conventional' valves, klystrons and magnetrons are described. Noise is given a fuller treatment than is usual in a general book of this kind. Space does not permit of more than a brief description of gas-filled devices.

This is one of the first general text-books to contain a treatment of transistors. The difficulties which beset an author writing on a subject like electronics can be seen from p. 199, where it is stated that the problems of quantity production of the germanium triode have not yet been solved; and on p. 216 it is suggested that point-contact transistors are already in use experimentally, but the junction transistor "if it can be made in quantity, will have many important uses". I agree that there is much to be done to make cheaper and more consistent transistors in large quantities; but the above statements scarcely represent the present position. They can be understood, however, when it is observed that, although the book was published in 1955, the author's preface is dated April 1952. Interesting chapters on electron optics, cathode-ray tubes and photoelectric devices complete the book. The rationalized M.K.S. system of units is used and standard symbols, except that $\varkappa$ is still retained for permittivity. Needless to say, there are no 'jars'!

The book can be thoroughly recommended for any of the three classes of reader for whom it is intended. The style of writing is easy, the author seeming to be in close touch with the reader. The diagrams are clear and fulfil their purpose. C. R. STONER

OPTICAL INVESTIGATION OF DIAMOND SURFACES

The Microstructures of Diamond Surfaces

By Prof. S. Tolansky. Pp. viii+67+143 plates. (London: N.A.G. Press, Ltd., 1955.) 40*s*. net.

INVESTIGATIONS of the surface topography of crystals have yielded many results of fundamental significance in recent years. The observations of growth spirals on the surfaces of crystals of beryl and carborundum which were made in Prof. S. Tolansky's laboratory provided some of the first evidence to support Frank's theory of the role of screw dislocations in crystal growth. Since then, it has been realized to an ever-increasing extent that the study of the microtopography of the surfaces which result from the final stages of crystal growth and from subsequent controlled sublimation, thermal etching, chemical attack or progressive dissolution provides one of the most powerful means of deriving information about the distribution of dislocations and their behaviour in crystals.

By his development and application of a series of essentially simple—yet surprisingly powerful—optical techniques which permit the quantitative study of surface features from the coarsest down almost to molecular dimensions, Prof. Tolansky has made a valuable contribution to this aspect of the physics and chemistry of solids. He has taken advantage of the opportunity provided by the publication of this volume to demonstrate the application of his methods to the study of the structures of natural surfaces, of cleavage surfaces, and of etched, polished and indented surfaces of diamond crystals. Multiple-beam interferometry, the powerful crossed-fringes technique and the light-profile method are clearly and briefly discussed and their utility and limitations outlined. The application of each technique to a number of different problems is well illustrated, and one of the most impressive features of the volume is the inclusion of one hundred and forty-three photomicrographs of outstanding quality.

The distribution of trigons on natural surfaces of diamond and the microtopography of these features as determined by the different optical methods provides one of the main topics of the book. The author expresses the very definite opinion that the trigons have their origin in phenomena which occur during the final stages of crystal growth, and that they are not to be attributed to localized attack on the surface as a result of changing physico-chemical conditions in the medium surrounding the crystals after the conclusion of crystal growth. He illustrates the experiments on controlled oxidation with molten potassium nitrate which have been carried out in his own laboratory with a further series of fine photomicrographs. No evidence has been found for the participation of screw dislocations in the processes of crystal growth and controlled oxidation in diamond.

The cleavage of diamond is of considerable interest to the physicist, the mineralogist and the lapidary, and the observation that Type 1 diamonds which absorb below 3000 A. have an imperfect cleavage compared with Type 2 diamonds, which only begin to absorb below 2000 A., is noteworthy. It is suggested that this may be correlated with the supposed greater purity of the Type 2 diamonds. In other substances, there is also often a correlation between the perfection of cleavage surfaces and the purity of the specimens.

The chapters on the formation of ring cracks on diamond surfaces by the application of a relatively lightly loaded hemispherical diamond indenter and on the comparative properties of the different crystallographic surfaces of diamond and the state of polish which can be achieved on them, although representing only an interim report on work which is still in progress, will interest engineers and metallurgists who are concerned with industrial diamond tools and indenters.

With his adequate elementary introduction to the optical techniques, and his beautiful illustrations of their application, the author can scarcely fail in his main objective in writing this book, which was to interest as wide a variety of workers as possible in the methods for the investigation of the microtopography of surfaces which have been developed in his laboratory. J. W. MITCHELL

Evolution of a Scientific View of the Universe in the Physics of the Seventeenth and Eighteenth Centuries

By B. G. Kuznetsov. (In Russian.) Pp. 344. (Moscow: Academia Nauk U.S.S.R., 1955.) 12 roubles, 25 kopecks.

THIS is the first of three volumes, published in the U.S.S.R., dealing with the emergence under the impact of science of a rational attitude in interpreting the universe. The present volume covers the age of Galileo and Newton. It is the result of careful studies of original writings: scientists of all nations are considered, and the story of their life and work is told with painstaking objectivity.

Unfortunately, the book is not so much concerned with the growth of scientific as distinct from pre-scientific thought as it is concerned with the political implications of this growth. The philosophical views of scientists are given undue prominence; they are placed side by side with the views of philosophers and other non-scientific writers and given good or bad marks by the way of appropriate quotations from Marxist authorities. All this is embedded in lengthy and incoherent narratives of political events and economic developments, submerging every finer and more subtle feature of scientific thought. The author, presumably an expert in historical documentation, seems to have only second-hand knowledge of science and is given to modes of pre-scientific thinking.

Science is presented in this book as a pitifully dull assemblage of trivial facts and outmoded speculations; unfortunately, this approach is not confined to Communist countries or to writers with Communist leanings. It is repellent to most scientists, who are in any event wary of history. Soviet scientists are not likely to take a more friendly view of a book of this kind than their Western colleagues. The present work could not even be recommended as a history of the social relations of science, although this is its main subject. R. Eisenschitz

Rufiji

By R. de la Bere Barker. Pp. 157+13 plates. (London: Robert Hale, Ltd., 1956.) 15*s*. net.

THIS is a simple and unpretentious account of life in the wilds of East Africa, with special reference to the birds and beasts, from hyenas scavenging around the native villages to the elephants that also come occasionally as unwanted visitors.

"One day," writes the author, "while I was resting in the shade of the high bank beside a water-hole from which we had drawn water for our tea, four elephants in file came striding up a path in the dry river bed of the Matandu River. They had a mighty thirst, and those who have experienced the scorching sun of the dry season in that land can sympathize with them. The tall elephants came right up close before they saw me and then they all made the neatest right-about-turn in complete silence. Off they went, one behind the other, just as they had come, perhaps reflecting gloomily to themselves that all the best places were being spoilt by trippers these days."

The illustrations are from most excellent photographs; for example, the plate facing p. 129, which is an aerial snapshot of a packed mass of hippopotami at rest on a mud bank. Such pictures bring home to one some idea of the teeming wild life of Africa, a wild life growing rapidly less before the advance of white settlements. Mr. R. de la Bere Barker is to be envied his long years among the creatures of this Rufiji area; the fish in the river, the snakes and other reptiles, the teeming insect throng, the innumerable birds, the many mammals, including the natives, are all described with a simple vividness that brings them to life on the printed page.

Frances Pitt

Organic Chemistry

By Prof. Lewis F. Hatch. Pp. vii+324. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 34*s*.

THIS very readable text-book is written for those, such as agriculturists and nurses, to whose main studies organic chemistry is ancillary. Prof. L. F. Hatch devotes thirteen of his twenty chapters to the more formal aspects of the science. He considers the simpler classes of compounds, the preparation of some prominent ones, and the behaviour of functional groups. His descriptions are clear and thorough, and he uses up-to-date reactions. Conforming to his plan, he does not account for chemical behaviour by the electronic theory or bring in quantitative work. His later chapters deal with such subjects as detergents, dyes, elastomers, enzymes, fats, fibres, medicinals, pharmaceuticals, and proteins. Each chapter ends with students' exercises and suggestions for further reading.

As is to be expected, much emphasis is laid on the economic and industrial application of the compounds. Whether he is discoursing on aspirin, rodenticides, or on chemicals to keep bread fresh, Prof. Hatch always makes his subject one of absorbing interest. His brightly written book, with its well-selected half-tone plates, is to be recommended to the class for whom it has been written. Moreover, the up-to-date reactions and the coverage of subjects such as petroleum and agriculture make this a suitable volume for a school science library.

G. Fowles

Bibliography on Hearing

Prepared by the Psycho-Acoustic Laboratory, Harvard University. (S. S. Stevens, Director; J. G. C. Loring, Compiler; Dorothy Cohen, Technical Editor.) Pp. vi+599. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1955.) 55*s*. net.

THIS remarkable compilation of more than ten thousand titles of publications on hearing up to the year 1952 inclusive represents a second edition of an earlier less ambitious "Bibliography on Audition", which was published in mimeographed form in 1950. In the first part of the work, titles are arranged alphabetically under the name of the first author, with cross-references in the case of multiple authorship. There is also a list of anonymous publications. Unabbreviated titles are listed in their original language, and are followed, if necessary, by a translation into English. The references are given in the abbreviations laid down in the "World List of Scientific Periodicals" (Oxford, 1934).

A classification of the subject under 315 headings is appended. The usefulness of this list is naturally limited, and its accuracy rather doubtful, as, in the majority of cases, the judgment of the compiler rests on titles only.

A glossary of abbreviations used in the references and definitions of relatively unfamiliar words, mostly from the Slavic languages, form a useful addition to a book which every worker in the field of hearing is bound to welcome as a guide to an alarmingly voluminous and widely dispersed literature.

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT

THE FIRST TEN YEARS

THE passing of the first ten years of the Atomic Energy Research Establishment, Harwell, was marked by a series of open days held in the last week of May. The last such occasion was in 1950, at which time the nuclear power programme was in its infancy and the work of the establishment was directed principally to helping the Industrial Group with the design problems of the production factories. As a result of the substantial relaxations in security classification made before the Geneva Conference on the Peaceful Uses of Atomic Energy last year, it was possible to show a large proportion of the work and the achievement of the Establishment in the first critical decade, much of it for the first time. Indeed, it proved possible to invite more than two thousand scientists and technologists from industry, government research establishments and universities to a 'University Open Day' on June 1, when visitors were able to move freely about the Establishment and select which of the exhibits they wished to see. Earlier in the week, members of both Houses of Parliament, correspondents of the international and technical Press and representatives of the surrounding district were invited to join parties touring the principal exhibits.

In the past five years the Atomic Energy Research Establishment has grown to be one of the largest research establishments in Great Britain. This rapid increase in size has been matched by a great increase in the available experimental facilities. New laboratories for the Chemical Engineering and Metallurgy Divisions have been built, and a new wing specially designed for the easy handling of highly active alpha-emitting materials has been added to the main radiochemical building. The Chemical Engineering Laboratory is of particular interest; it is a galleried building carefully designed for the speedy erection of large pilot-plant scale experiments involving active materials. In addition to BEPO and GLEEP, four other reactors are now in operation. All four new reactors are low-energy reactors primarily designed for research into the reactor physics of a particular system. Thus DIMPLE is a heavy-water reactor in which many different types of core can be built; for example, the basic design of the Materials Testing Reactor DIDO, now approaching completion at Harwell, was investigated in this reactor. Another reactor ZETR was built in order to determine the basic physics of simple types of low-energy homogeneous aqueous reactor. Of special interest are the reactors ZEPHYR and ZEUS, which are the low-energy precursors of the fast reactor experiment now under construction at Dounreay. It is especially interesting that, in the ZEPHYR reactor, experiments have revealed that, for each plutonium atom undergoing fission in the core, 1·7 atoms of uranium-233, another fissile nuclide, are produced in a thorium blanket by capture of neutrons escaping from the core.

In general, the work of the Establishment is now concerned with the basic science and technology of all the civilian aspects of atomic energy, although some assistance is given to the Weapons Group on specific problems. Thus for two years the Establishment carried out technology and feasibility studies on the prototype graphite-moderated gas-cooled reactors which are now being built at Calder Hall. The first reactor there became divergent just before the open days began, and the heat produced will be used for generating electricity for the National Grid in the autumn. Harwell has now a good deal of work to do in helping industry in the development and design of the improved power stations of this kind which are to be built by the Central Electricity Authority in Stage I of the government nuclear power programme. Among examples of this kind of work shown was the continued study of the reaction between carbon dioxide and graphite in a 'loop experiment' in the BEPO reactor.

Work is going on at Harwell and in the Research and Development Branch of the Authority's Industrial Group on the second stage of the nuclear power programme, when it is expected that plutonium from the Stage I reactors will be available to enrich reactor fuels. Reactors of two kinds are being considered for this stage: one uses light (that is, ordinary) water as both coolant and moderator; the other uses liquid sodium as coolant and graphite as moderator. The technical problems involved in either of these reactor systems require a good deal of development work, particularly on the acute corrosion problems which arise. Their main advantage over the gas-cooled type is that they have a lower initial uranium investment and may have slightly lower capital costs. It is expected that a prototype of the selected reactor will be built in about 1960, and, if they prove to be attractive economically, they might replace the gas-cooled stations in the later 1960's. The work shown on these competitive systems included the water and liquid sodium loops installed in BEPO.

Research and development work is also proceeding on reactors the potential large-scale use of which is still further off in time—the 1970's. The object here is to achieve 'breeding' in order to reduce the amount of uranium required to develop power by a hundredfold. The 'fast reactor' is the first of these. A large-scale fast power-reactor experiment is being built at Dounreay in the North of Scotland and two precursors, ZEPHYR and ZEUS, have been built at Harwell to study the breeding potentialities and the nuclear properties of fast reactors using plutonium and uranium-235 as fuel. ZEUS, which was on show during the open days, has the same physical size and design as the Dounreay reactor, but is operated at a very low power level in order to study the physical characteristics of the reactor system. A number of other advanced reactor systems are being studied. Among these is the homogeneous aqueous reactor which uses a liquid instead of a solid fuel; the liquid is likely to be a uranium salt in heavy water. Some of the work on the continuous processing problems involved in these reactors was shown in the Chemistry and Chemical Engineering Divisions. Work on other systems such as the liquid metal fuelled system and the high-temperature gas-cooled reactor was exemplified by current work in chemical engineering on the problems of dissolution in liquid metals, and in metallurgy on the fabrication of ceramic and cermet materials.

In order to carry out this programme, an extensive range of experimental and testing facilities is required. Typical of the extensive experimental facilities required for such a programme is the new wing which

has been added to the Radiochemical Laboratory. This laboratory area is fully equipped for the handling of relatively high levels of alpha-activity. Flexibility, which is of great importance in such laboratories, is obtained by the use of free-standing glove-boxes. All the essential services are fed to these boxes from the roof void, and maintenance or replacement of components inside the boxes is performed in a specially designed area to which access may only be obtained in a protective rubber suit. The eight-year-old general-purpose BEPO reactor is currently being used for at least fifty experiments, and so several new reactors for specific purposes are being built. DIDO, models of which were on show, is a materials testing reactor which is expected to be completed in August. The neutron intensity thus made available will be forty times greater than that in BEPO, and development work will be enormously speeded up thereby. PLUTO is a similar reactor to DIDO except that there are extensive facilities for the testing of loop circuits installed in the reactor. LIDO is a swimming-pool reactor intended primarily to help solve the problems of reactor shielding design.

The isotope programme will also benefit from the increased flux available in reactors like DIDO and PLUTO. At the moment radioactive cobalt-60 is produced at the rate of about 12,000 curies per annum for hospitals and industry. It is expected that DIDO and PLUTO will produce about 50,000 curies of cobalt-60 per annum. Even then there will not be enough of this material to meet the rapidly expanding demand. In general the facilities for developing the applications of radioisotopes to industry are being expanded. An interesting feature of this expansion was the formation of the Technological Irradiation Group a short time ago, and some of the lines upon which the Group is developing were shown. An important feature of the work of this Group is the close collaboration with industry which is to be increasingly encouraged in the future. Stable isotopes are also produced in electromagnetic separators, two of which were shown by the General Physics Division. The latest of these to be developed has a specially designed high resolution for the heavier elements.

The very extensive supporting technology required for an atomic energy programme in all its stages was demonstrated by work going on in many of the laboratories. For example, it is very important to undertake a preliminary ore separation at the mine, and the mineral-dressing laboratory at Harwell is investigating these difficult problems. The Electronics Division is concerned with the development of apparatus for radiometric geological survey to assist in uranium and thorium prospecting, and equipment for prospecting and assay was shown. New methods for the production of uranium and thorium metals from purified oxides are continuously under development, and work in this field and in the field of fabrication of prototype fuel elements for research reactors and reactor experiments was on view. The Reactor Division is primarily concerned with the setting up of experimental critical assemblies of uranium and moderators for all new-type reactors in the programme, and in this way the physics of the reactors can be studied. The chemists and chemical engineers were able to show a great deal of their work on the processing of reactor fuels and on the methods used in separation of the useful fission products and the disposal of the remainder. Among the most interesting examples of this kind of work were experiments designed to investigate the processing of reactor fuels by high-temperature melting, slagging and vaporization techniques. Such methods may in the long run eliminate the expensive dissolution and metal recovery stages necessary in wet reactor-fuel-processing methods. It is expected that large quantities of the recovered useful radioisotopes will be sold to industry in increasing amounts. There is also a considerable amount of co-operation with industry in the development of the important moderator and fuel element materials such as graphite, heavy water, zirconium and beryllium and in the development of the complex electronic instrumentation of the whole project. So far more than four hundred instruments have been developed by such collaboration.

In addition to the technological work of the Establishment, about 20 per cent of the staff work on fundamental research in nuclear physics, radiochemistry, solid-state physics and theoretical physics. The work in nuclear physics is concerned with the use and development of fundamental research tools such as the cyclotron and linear accelerators. The development work on proton linear accelerators and high-energy machines is, for example, concerned with the accelerator to be used as an injector, the magnet and radio-frequency power triode valve design. The first tank of a 50-MeV. proton linear accelerator with its auxiliary equipment has been completed. Other important work of the Establishment includes a long-term research programme on the possibility of controlled thermonuclear reactions. This programme is of great scientific interest since it combines the field of high-temperature and nuclear physics; but it is far away from any practical application.

A. H. S. Matterson

PROPULSION PROBLEMS IN HIGH-SPEED FLIGHT

By H. CONSTANT, C.B.E., F.R.S.

THE Parliamentary and Scientific Committee recently visited the National Gas Turbine Establishment, Pyestock, and inspected some of the research and development work proceeding there. The Committee was shown a general cross-section of the interests of the Establishment; but the greater part of the visit was devoted to work on the engine problems of high-speed flight.

The engines in production to-day, although basically designed for subsonic operation, are still quite suitable and effective at speeds up to about twice that of sound. All the old problems remain, of course, and many of these tend to get more difficult rather than easier. Thus, whatever the speed of flight, so long as we use a turbo-jet for propulsion, we shall have the aerodynamic problem of making compressor and turbine blading to give the greatest energy conversion for the lowest losses, with characteristics producing a stable and flexible engine; we shall have the problem of developing the greatest possible heat release in a combustion chamber of restricted frontal area, while maintaining a low pressure loss and

a sufficient range of stable operation under all conditions of flight; and we shall have the problem of so disposing of the material with which the engine is made that every ounce of it is stressed right up to the maximum safe limit, bearing in mind all the vibratory and transient loads to which it may be subjected. We have, and always have had, these problems, to name but a few of the many which define the development background of the gas turbine. Examples of the work being done on these subjects were shown to the Committee.

Now, however, that the speed of flight is moving deeper into the supersonic range, a set of problems which are either quite new, or which have only so far given us a glimpse of their full capacity for causing trouble, are beginning to arise. Of these new problems, probably the most difficult to assess fully with our present limited experience is that of engine control. In the jet engine of to-day, the number of independent variables can be made sufficiently small to justify the practice of designing control systems by trial and error. But in an engine designed to operate over a wide range of speeds up to, say, three times the speed of sound, it will be necessary to introduce a number of new variables each of which will need controlling to suit the environment of the engine. In the first place, the swallowing capacity of the intake does not vary with aircraft speed in the same way as does that of the engine, It is, therefore, necessary to adjust the geometry of either the intake or the engine in order to match their capacity to pass air. Our present thoughts are that the intake should be adjusted as the flight speed changes, since an adjustment to the engine would be less easy to make. A similar adjustment to the capacity of the propelling nozzle to pass exhaust gases will have to be made when extra thrust is obtained by reheating, that is, by burning fuel in the exhaust pipe. This adjustment will involve the awkward process of changing the throat area of the nozzle. At high supersonic speeds it is necessary, if the highest thrusts are to be developed, to use a nozzle of a convergent–divergent shape, like an hour-glass in cross-section. If efficient and stable operation is to be obtained over a wide range of flight speeds, the outlet area of this nozzle must be made variable. This quite complex mechanism must be so designed that leakage past the movable parts is small, and cooled so as to operate satisfactorily when passing gas at a temperature of 2,000° C.

Thus a movement of the pilot's throttle, in addition to regulating the rate of admission of fuel to the main engine, and to the reheat system separately, must also control the air-intake and, in two degrees of freedom, the exhaust system as well. These controls will need to be cross-linked to a function of the aircraft speed. One of the principal difficulties anticipated here is likely to occur as a result of a sudden movement of the pilot's throttle. For if the rate of response of the engine to the various changes being made to its environment has not been correctly judged, complete loss of control may result. The Committee was given a demonstration of an engine being operated so as to give the response-rates on which a rational control system could be based.

Another difficulty that we know will become formidable at the higher flight speeds arises from the fact that the intake air will, at these speeds, be becoming uncomfortably hot. Due to the motion of the aircraft there is a rise in temperature of the air in the intake which is proportional to the square of the speed of flight. As a result of this, the temperature of the air at the engine intake increases rapidly with speed, and at 2,000 m.p.h. in the stratosphere will be as much as 350° C. After entry the air will be further compressed and would enter the combustion chamber at around 500° C. The thrust that can be obtained from an engine depends very much on how much heat can be added to the air after it has entered the combustion chamber, and this is controlled by the limits set to the temperature at exit from this chamber. At present this exit temperature is limited to about 900° C. by the materials used in the blading of the turbine. Thus the temperature rise in the combustion chamber in the example quoted above will be only 400 deg. C. This would result in a very inadequate output of thrust. The most effective way of overcoming this disability is by cooling the turbine so that the limit of gas temperature at present fixed by the properties of the material used can be raised. If, for example, the turbine can be cooled by air so that the temperature of the gases entering it can be raised from 900 to 1,200° C., then the temperature-rise in the combustion chamber would go up from 400 to 700° C. and a very considerable increase in thrust would result (about 70 per cent).

Thus, as the speed of flight increases, although the thrust requirements of the aircraft also increase, the thrust available from the engine would actually decrease if its maximum gas temperature were maintained constant. This limitation can be overcome by cooling the blades and other surfaces of the turbine so that the gas temperature can be raised without the temperature of the metal exceeding a safe limit. This process can be continued until the temperature of the cooling air, which has to be drawn from the engine, becomes so high that it can no longer act effectively. It is difficult to cool with air at 500° C. when this imparts a dull red heat to the surfaces which it scrubs! When this limit is reached, further progress can be made by refrigerating the air before it is used for cooling; but this process involves an increase in both weight and drag. The Committee was shown a heat-transfer cascade tunnel, which has been used for providing the basic data on cooling, and a turbine designed in the light of these data, which has been operating during the past few years at temperatures as high as 1,100° C.

No very clear picture of the behaviour of a gas turbine can be obtained until its major components —its compressors, turbines and combustion chambers —have been tested separately under as wide a range of conditions as possible. From the results of such tests of components, it is possible not only to predict the performance of the complete engine but also to visualize profitable lines of development for improving the performance. Such tests as these have already become routine for engines designed for subsonic flight. They will be all the more necessary under the more arduous conditions already being experienced at high speeds. The Committee was shown tests being made for industry on compressors and combustion chambers destined for jet engines for high-speed flight, and was given demonstrations of some of the hazards involved in the testing of complete engines under simulated conditions of high-speed flight at altitude.

There is no doubt that the attainment of speeds of around 2,000 m.p.h. will pose plenty of problems for the propulsion engineer; but clear ways through these difficulties are already beginning to open up.

WHY LABORATORY ANIMALS DIE

DURING April 11–13 there were two meetings at the Royal Veterinary College, London. On the first two days the Laboratory Animals Bureau held its ninth annual congress of animal technicians; and on the third day a symposium on infections in laboratory animals attempted to summarize current problems in this field.

The symposium was the fourth to be held, and its main audience consisted of graduates, in contrast to the congress. The fact that such meetings continue to attract attention each year is of interest in itself, indicating that the animal house is no longer considered unworthy of scientific consideration, although in many cases it still attracts too small a proportion of the laboratory budget.

To compare laboratory animals with chemical reagents is an analogy that has become hackneyed and, if followed too far, is misleading. Reagents they may be to the biologist, but they have characteristics distinguishing them sharply from the inanimate substances with which the chemist has to deal. They are not inanimate but living; and they are not a homogeneous mass but distinct individuals, however nearly the ideal of individual similarity or uniformity may be approached.

Laboratory animals are thus exposed to one especial hazard, namely, accidental intercurrent infection. As a result of this hazard the animal may die, or the group lose any degree of uniformity it may have possessed before infection or might be expected to possess without it, and then its value as a reagent is diminished or destroyed. The deaths from intercurrent infection are not accurately known except in those laboratories where careful records are kept—and there are too many where they are not. A. A. Tuffery, speaking at the symposium on epidemiology and laboratory mice, and Dr. J. S. Paterson, in his paper on the control of infection in rabbits, both indicated that such losses are far from negligible, and may on occasion be disastrous; nor can a remedy be proposed in the absence of more detailed recording of incidental losses and their analysis and investigation. This point is to-day widely, if not universally, appreciated, and to recognize a problem is the first stage towards its solution.

The problem is not an exclusively veterinary one. The emphasis in every paper was not so much on the treatment of infection as an untoward experience of individual animals, but on its prevention, control and elimination. Prof. W. L. Weipers, in his paper on the control of infection in laboratory cats and dogs, particularly stressed this approach, as did Dr. R. F. Gordon, speaking on the control of infection in laboratory poultry. A more particular approach was indicated by Dr. M. H. Salaman, who has examined vaccination as a method for the control of ectromelia in mouse colonies; and by Dr. Joan Taylor, who dealt with the commonest, and therefore the most important, of all infections—*Salmonella* infection in laboratory animals. Dr. B. Moore and Dr. A. P. Goffe spoke respectively on infection in laboratory guinea pigs and infections in laboratory monkeys. Indeed, four out of eight titles included the word 'control', and all had a decidedly epidemiological twist. The same theme was emphasized by the chairman, Prof. J. W. Howie, who also added that non-bacteriologists might perhaps with advantage learn to attribute some of their losses, if recorded, to infection rather than to the natural tendency of animals to die.

That laboratory animals do die when they are required to stay alive is beyond dispute. The proportion of those born that fail to survive to weaning age may in some species, for example, rats and rabbits, be as much as one-fifth, or more. Nor are serious losses confined to the nursing period; disease may take its toll on occasion at any age. That the wastage should be so high in rats is alarming; yet very little was mentioned at the meeting about infection in rats, for the reason that very little appears to be known. Something is known about rabbit diseases, but not enough to prevent serious infantile losses. Mouse colonies have been the subject of many classical epidemiological experiments, and some thirty or more incidental infections of mice have been described, four of which are of outstanding importance (ectromelia or mouse pox, salmonellosis, focal necrosis of the liver or Tyzzer's disease, and infantile diarrhœa). Yet, of two out of these four the ætiology is unknown or uncertain, in one the infection is extremely widespread if n t universal, and in one only is there any prospect of real control through vaccination.

The situation with regard to guinea pigs is better, for their bacterial diseases at least have been studied in some detail; but new light has been thrown on their possible mode of transmission through the conjunctiva or, possibly, the upper respiratory tract. Nutrition and other environmental factors probably play an important part in the diseases of monkeys, which in any event are too numerous and serious for any degree of complacency. The problem of keeping a considerable number of cats in one place without the serious risk of devastating outbreaks of disease is still unsolved, although much is known about the commoner diseases of this species. Dogs present fewer such problems, perhaps because of the great competence of the veterinary profession with respect to them.

A decade ago, certainly two decades, meetings of this kind might have passed unattended and unnoticed. To-day, the Laboratory Animals Bureau does not lack encouragement to continue to make both the symposium and the congress annual events.

The attendance at the congresses numbers regularly nearly two hundred, and the high standard of contributions by technicians is maintained year after year. Of particular interest this year was the paper by Dr. J. F. D. Frazer on some aspects of the breeding of laboratory animals, in which he pointed out the effect on the natural functions of the animal, especially on breeding, of such environmental factors as light, heat, diet, cage-size and design, quality of care and much besides. He was addressing technicians, animal technicians for the most part, and he seemed to be inviting them to make their own contributions to knowledge of animal care and good husbandry.

This brings up a point of more than trivial interest. The term 'animal technician' first achieved formal status six years ago, when the Animal Technicians Association was founded. After six years it is time for it to be generally adopted and for the older terms applied to animal house staff to be dropped. The

grade of animal technician is recognized by many employing authorities, such as the Medical Research Council, which have undoubtedly learned that good animal technicians mean good animal material for research and investigation. Some universities recognize the grade, but others do not; the National Health Service does not, nor is the animal technician represented on the Whitley Council. Where recognition has occurred, it has been found to pay in terms of better animals, better work and (if costs are known) less extravagance through avoidable wastage. Why, then, are some employing bodies reluctant to follow the excellent lead given by others? No animal houses in Great Britain are so bad that they could not be worse; but many are not so good that they could not be better if unskilled labour were to be gradually replaced by qualified animal technicians.

Although we may regard our standards in Britain with some satisfaction (but with no complacency), too many laboratory animals still die of infection. Some of this wastage could be prevented by more skill employed in their care and management, by the application of existing knowledge of laboratory animal diseases, and by the investigation (mainly epidemiological) of diseases still imperfectly understood.

The symposium will be fully reported in Laboratory Animals Bureau Collected Papers, Vol. 4 (obtainable from the Bureau at the Medical Research Council Laboratories, Holly Hill, London N.W.3). The Congress will be fully reported in the *Journal of the Animal Technicians Association* (obtainable from the honorary secretary of the Association, Mr. A. E. Mundy, 5 Ouse Bridge Drive, Carlton, Notts).

W. LANE-PETTER

FOOD TECHNOLOGY AND NUTRITION

THE 101st meeting of the Nutrition Society (the 46th meeting of the Scottish Group) was held in the Biochemistry Department of the University of Edinburgh on April 28, under the chairmanship of Prof. G. F. Marrian, when the subject of "The Impact of Food Technology on the Nutrition of Man and Animals" was considered. In opening the meeting, Prof. Marrian stressed the enormous importance of the topic under discussion, since so much food is processed. As one speaker pointed out, if it is accepted that food processing includes all treatment received by a foodstuff from its point of origin to the point in space and time when it is consumed, then barely 2 per cent of our food expressed in terms of calories receives no processing. Prof. Marrian also referred to the bigger and almost frightening problem of world food production, and suggested that the topics to be discussed that day warranted consideration over at least several days.

The first paper, on food processing and nutritional values for man, was by Dr. H. R. Barnell and Miss D. F. Hollingsworth, of the Ministry of Agriculture, Fisheries and Food. Miss Hollingsworth, who read the paper, pointed out that the application of heat to starch is essential for its digestion; that excessive heating of fat may cause production of acrolein; and that proteins are sensitive to the application of excessive heat and to the removal of heat. Starch, sugars and proteins in foods are not normally affected by atmospheric oxygen; but powerful oxidizing agents may have an effect. Fats may become rancid on storage, particularly in the presence of air. Rancidity may also be caused by the activity of micro-organisms. Development of oxidative rancidity is affected by temperature, light, moisture and by traces of various minerals (cobalt, copper, iron and manganese) and can be controlled by addition of antioxidants. Rancidity, besides reducing the value of fat, has adverse nutritional side-effects. Of the fat-soluble vitamins, vitamin A is relatively stable to heat if oxygen is excluded. Light also accelerates oxidation. Vitamin D is moderately stable to heat, light and oxygen. Vitamin E is fairly stable to heat but is destroyed during development of oxidative rancidity in fats. Riboflavin and nicotinic acid are more stable to heat than vitamin B_1, which is the most labile of the B complex. Riboflavin is unstable to heat and light. Vitamin C is unstable in presence of oxygen and is destroyed in sunlight.

It is possible that a combination of light, heat treatment and a radiation sterilization treatment will give eventually more attractive products than those produced by present methods. While on the whole it is true that the effects of processing on the nutrients in foods tend to give an impression of losses of nutrients whenever a food is given any form of treatment, it was emphasized by Miss Hollingsworth that the processing of foods is to a large extent a necessity to make them edible and palatable, transportable and storable. The final result is therefore greatly to increase the supply of nutrients to the world's populations.

Dr. J. M. Barnes, of the Medical Research Council's Toxicology Unit, followed next with a paper on the potential toxicity of chemicals used in food technology. He mentioned that many of the substances used as food additives possess no outstanding toxic property; others which may be used as adjuncts in processing or preservation may be toxic, but are present in the food only in very small quantities. The study of non-toxic substances resolves itself into the problem of trying to prove a negative.

Food manufacturers and allied commercial interests are so aware of the problem of toxicity that Dr. Barnes considered it unlikely that any material with demonstrable toxic properties will ever be included in food prepared in accordance with reputable trade practices. However, these may appear in food in trace quantities as the result of current practices such as compounds with well-marked toxic properties and active as insecticides, fungicides, germicides or endowed with other special properties. A safe dose is one which the body can dispose of without harm to its normal metabolism. Difficulties arise when no clear-cut toxic response occurs with larger doses. There are some who suggest that in some unspecified way the prolonged consumption of such substances over long periods may injure health. It has been shown that, in the case of certain toxic substances, the disposal of small non-toxic doses may be quite different from that used when larger quantities are given.

Dr. Barnes illustrated the biological complexities by reference to maleic hydrazide, a potato sprout depressant which produces inhibition of plant growth at concentrations of a few parts per million, and yet rats and other animals will grow and thrive on a diet containing as much as 1 per cent of it. When used properly, residues of 10–15 p.p.m. may remain in the potatoes at the time they are consumed. It has been suggested by the work of Waggoner and Dimond that maleic hydrazide exerts its effects on plants by stimulating the enzymic hydrolysis of indole acetic acid, so depriving the plant of this auxin. But cytological changes include chromosome splitting. As many carcinogenic substances have a similar effect on mammalian cells, it has been suggested that maleic hydrazide should be tested for its carcinogenic effects before being used for human consumption. The uniformly negative result of tests on mammals suggests that maleic hydrazide on potatoes in 10–15 p.p.m. would not be harmful, though it does not amount to *proof* that it would be entirely safe. The steam volatility of another sprout depressant, tetrachloronitrobenzene, during cooking indicates that the physical and chemical properties of substances added to food play as important a part as the biological properties in determining whether a health hazard will be associated with their use.

While there are comparatively simple acute tests which seem adequate for distinguishing powerful carcinogens, a definition of a 'weak carcinogen' has not been provided. Surface-active agents may have interesting biological effects; but whether or not these effects will be shown if the emulsifiers are added to bread has not yet been determined.

Not only may the chemicals added to food become altered, but so too may the food itself and the products of such reactions might be toxic. The classical example is the agene process of improving flour. Agenized flour is toxic to dogs, cats, rabbits and ferrets, but rats and monkeys are relatively insensitive. Dr. Barnes quoted experiments in the United States on nineteen humans, including five epileptics, who were given flour treated with 20–30 times the usual quantity of agene but without showing any change in behaviour, general physiology or electro-encephalogram. The monkey requires at least a hundred times the dose of the active toxic agent, methionine sulphoximine, needed to induce fits in the dog. A man eating 2,000 Cal. per day as agene-treated flour ingests a dose of 1 mgm./kgm. methionine sulphoximine; the sensitive dog requires a dose of 2–4 mgm./kgm. to produce fits and kill the animal. The nature of the toxic action of methionine sulphoximine has not been defined: species differences may be due to speed and ability to dispose of the toxic substance.

Where no positive effects can be observed on animals with a given substance, then a hypothetical risk may be incurred if such a chemical is added to food. In Dr. Barnes's view, this should in some way be balanced by the simultaneous conferment of some benefit to those who incur this risk.

Mr. N. W. Pirie, of the Rothamsted Experimental Station, in his paper on unexploited technological possibilities, pointed out that the three outstanding possibilities for increased food are: the synthesis of food, the more economical use of crops of the type we already grow, and the exploitation of new primary sources of food. In his opinion we would continue to rely mainly on photosynthesis rather than on synthesis of the bulk foods. Few people get less than half their energy from vegetable sources, and most of the world's population gets nearly all its energy in this way. One solution of the food problem would therefore be to increase the amount grown.

Diets eaten in many parts of the world are inadequate, having many faults; protein deficiency being a common one. Some legume seeds contain adequate amounts of protein; but many tubers such as cassava contain very little. Many leaves, which can now be stored by refrigeration, contain as much nitrogen as the legume seeds. Investigation of systems of husbandry that would ensure large yields of protein-rich and fibre-poor leaves is a technological possibility that deserves fuller exploitation. Even normally despised grasses would be useful if grown regularly with 25–30 per cent of protein.

The protein in the leaf is already there and valuable, needing only separation from dilute carbohydrate. Since the time of Rouelle (1773) it has been extracted from leaves and coagulated. The pulper described by Mr. Pirie is the end-product of much experiment, and is reasonably satisfactory in separating juice from fibre. The protein can be precipitated from the juice by letting it age, by heating to 75° C., by adjusting *p*H to about 4 or by shaking it with a variety of water-immiscible liquids. Different preparations vary somewhat in digestibility, and the reasons for this are being investigated. Mr. Pirie thinks it wise to postpone careful feeding-trials until this phenomenon is more fully understood; but he stresses the need for a much more adequate scale of research in this important field. He considers it illusory to believe that algae, such as *Chlorella*, are peculiarly efficient at trapping light and giving a greater return per acre-year than other crops.

The sea is an under-exploited environment, and both the harvesting of marine microflora and the use of the material harvested are ripe for technological investigation. Mr. Pirie believes that, if Britain cannot continue to buy its food from the rest of the world, it must come to live on its own acres and then it must change its style of eating.

In his account of some technological developments of importance in animal nutrition, Dr. J. Duckworth first pointed out that most of the common energy sources are often too low in protein for productive purposes and must be supplemented to secure appropriate ratios of metabolizable energy to digestible protein. All protein-rich supplements are expensive, relative to the basic energy sources, and thus minimum feeding costs are realized only when supplements are added at the level that justifies the animal's needs. In practice, a margin of safety must be added, and the greater the uncertainty about the dietary protein the greater this margin must be. Sources of uncertainty are: variation in protein content among different batches of individual feeding-stuffs, variation in amino-acid composition within the total protein content, natural variation in protein digestibility, and variable effects of processing on protein quality, defined in terms of digestibility and of metabolic availability of certain important amino-acids of the digested protein. An independent source of uncertainty is variation in the metabolizable energy of feeding-stuffs disturbing the nutritive ratio.

Important features of research and technical development are studies on processing to obtain by-products of uniformly high protein value, of the inheritance of desirable amino-acid levels in feed proteins, of the synthetic production of amino-acids

and of applying nitrogenous fertilizers to raise the protein content of crops of high-energy content.

In Britain there is the problem of making efficient rations for the livestock with feeding-stuffs of diverse and fluctuating origin and kind. The nation is dependent on the technological capacity of manufacturers abroad; for example, half the national supply of protein concentrates was imported in 1953 and 1954. In 1955 there was a large increase in supplies, mainly of imported oilseed meals. So far, continued Dr. Duckworth, little research on the nutritive value and still less on local processing methods has been published from most sources of these feeding-stuffs. Processing has generally a profound effect on the nutritive value of protein concentrates and, if inadequately controlled, yields highly variable products. Only on fish, herring, soya-bean and cotton-seed meals has extensive research been done, and then almost entirely from the point of view of suiting the products to non-ruminant needs. A recent trend has been to process oil-seed meals for high solubility of protein. Such materials are contra-indicated for ruminants under preferred British feeding systems. Attention is now being given to developing rapid laboratory tests of protein quality. If success is attained, an appropriate amendment of the Fertilizer and Feeding Stuffs Act would give protection against low-value protein concentrates of domestic or imported origin, and thus lead to more efficient compounding of rations.

Many members and visitors took part in the discussion which followed.

SCIENCE HOUSE, PAKISTAN

THE visitor to Pakistan cannot fail to be impressed by the rapid scientific development which is taking place there. The science departments in the older universities are expanding; new universities have been created in Sind, Karachi, Peshawar and Rajshahi; the Central and three Regional Laboratories of the Pakistan Council of Scientific and Industrial Research have been established, and important research institutions, such as the Cotton Research Institute, the Jute Research Laboratory, the Pakistan Standards Laboratory and others, have come into being during the past three years. The new buildings, many of which have been completed, are very impressive. The sites are spacious and convenient, and the buildings, of pleasing design, have been planned with imagination and foresight. There is ample accommodation for many years to come, and expansion will not be hampered by considerations of space. These institutions have been provided by the State, and are a reflexion of the importance attached by the Government to the part which science must play in the development of the country.

The Pakistan Association for the Advancement of Science was founded in 1947, and has been very active, having started the publication of Pakistan's first scientific journals—the *Pakistan Journal of Science* and the *Pakistan Journal of Scientific Research*—and organized the annual All-Pakistan Science Conferences.

A new development of great importance has just been launched. The foundation stone of the Ismail Aiwan-i-Science (Science House), Lahore, was laid on January 27, 1956, jointly by Mr. Nasser Ahmad Shaikh, and the representatives of science associations from Australia, China, India, Pakistan, the U.S.S.R., the United Kingdom and the United States.

Science House will be the integrating centre for science in Pakistan. It will contain a large science library and a bibliographic, translation and documentation centre equipped for microfilming and duplication. There will be an auditorium to seat a thousand persons. There will be accommodation for a Human Relations Research Centre, which will be concerned chiefly with social science research. Science House will also contain office accommodation for the various scientific societies, together with seminar and committee rooms, and a press and publications section for the various scientific societies and organizations. There will be residential accommodation for visiting scientists, club rooms and a cafeteria.

The building is situated in the new modern residential centre of Lahore, adjacent to the new Regional Laboratories of the Council of Scientific and Industrial Research, and close to a number of important educational institutions and the proposed new site for the University of the Panjab.

This magnificent project was conceived by Dr. Bashir Ahmad and his colleagues, and has been made possible through the generosity of Mr. Nasser Ahmad Shaikh, a leading industrialist in Pakistan, who has provided the funds for building Science House.

The new building will be completed early in 1957, and the next annual meeting of the Pakistan Association for the Advancement of Science will be held in it.

GEORGE ALLEN

OBITUARIES

Dr. Walter Sydney Adams, For.Mem.R.S.

WALTER SYDNEY ADAMS, the son of a missionary, was born in Antioch in northern Syria on December 20, 1876. He was educated at Dartmouth College and the Universities of Chicago and Munich, and was appointed an assistant at the Yerkes Observatory under Hale in 1901. In 1904 he was one of the small staff which went with Hale to Mount Wilson to start the new Observatory in California. As assistant astronomer, as assistant director, as acting director during Hale's illness, and from 1923 onwards as director, he devoted his life to the Observatory until his retirement in 1946. As a research associate of the Carnegie Institution of Washington and of the California Institute of Technology, he continued working on astrophysical problems, his last paper on the shell star α Orionis appearing in the March issue of the *Astrophysical Journal* this year. He died on May 11, 1956.

Adams's earliest publications were on line-of-sight velocities of stars, on spectroscopic binary orbits, on stars of variable velocity and on details of spectro-

graphs and allied instruments in use in the Observatory. He showed an early interest in the spectra of novæ, in the characteristics of sunspot spectra and in the comparison of centre and limb spectra in the Sun. His measurement of solar rotation at different levels in the solar atmosphere showed that the higher strata rotate faster and with a smaller equatorial acceleration than the lower strata. His next major contribution to astrophysics, the one for which the Gold Medal of the Royal Astronomical Society was in large part awarded in 1917, was the spectroscopic determination of stellar parallaxes. The first paper with Kohlschütter on the criteria provided by varying relative strengths of spectral lines for determination of absolute magnitudes of stars appeared in 1914. Afterwards Adams extended the work to cover a much wider range of spectral types and he published spectroscopic parallaxes of thousands of stars. His work led to a direct probing of the galaxy to far greater distances than had hitherto been possible except by statistical methods.

Among much other work of his mention must be made of his analysis of high-dispersion spectra and the calibration of Rowland's scale of intensities; in novæ he noted the simple 1 : 2 : 3 relations between the velocity displacements of successive outbursts: high-dispersion spectra enabled him to detect as many as five clouds of interstellar gas in the same direction in space moving with different line-of-sight velocities. Adams also both detected the white dwarf nature of the companion to Sirius and afterwards the relativity displacement to the red of the lines in its spectrum—a displacement of +19 km./sec. as compared with Eddington's predicted value of +20 km./sec. at λ4500.

Adams was president of the Astronomical Society of the Pacific and later of the Astronomical Society of America. He was vice-president of the International Astronomical Union during 1935–49, keeping the Union alive during the Second World War. He was the senior associate of the Royal Astronomical Society, a foreign member of the Royal Society and a corresponding member of many other national academies. He was awarded the Draper Medal and the Bruce Medal in America, the Prix Janssen and the Janssen Medal in France as well as the Gold Medal of the Royal Astronomical Society. In his death the astronomical world has lost a much loved and widely revered leader. F. J. M. Stratton

Mr. P. W. Wood

It would seem strange to anyone in Cambridge to speak of Philip Worsley Wood in any other way than as "P. W.". His passing is a great loss to Cambridge and especially to Emmanuel College, as was that of his namesake Alex. a few years ago. Born in April 1880, he matriculated and entered Emmanuel in 1899.

To one who was his exact contemporary, the passing of "P. W." comes as a reminder that the ranks of those who took the Mathematical Tripos Part I in the days when there was an order of merit are becoming very thin. In 1902 he was Third Wrangler, bracketed with H. A. Webb. In 1903 he was placed in Class I, Division 2 in Part II of the Tripos, and in the next year was awarded a Smith's Prize.

"P. W." had in a high degree that facility in the solution of ingenious problems which counted for so much in the Tripos of that day. But it was not the kind of outlook for which the times were asking. With the passing of the old Tripos, mathematical fashion was for connected theory, ever widening in scope and in new points of view. Thus Wood became one of that band of teachers who held the fort for that wide range of students for whom mathematical research lay beyond their reach. As such he was an outstanding member of his College and of the Faculty. To his pupils he was devoted, meticulous and challenging. Though he retired at the age of sixty-five under the age limit, he went on teaching for the love of it until the day when he was overtaken by the illness which led to his death ten days later.

Being what he was, his original work was limited. The best known was his Cambridge Tract on "The Twisted Cubic". Not so well known was a series of papers in the London Mathematical Society *Proceedings* on algebraic invariants.

His activities turned early to College administration. A Fellow of Emmanuel for fifty-one years, he served for thirty-five years as lecturer in mathematics, for twenty-six years as librarian and for seventeen years as senior tutor, besides acting for some periods as vice-master. In University affairs he was not so prominent, though he was a junior proctor in 1917–18 and was for many years a much-valued member of the Local Examinations Syndicate.

As a man, "P. W." cannot be put into any class. He was just himself—kind and appreciative but caustic and terse in conversation, diligent in all that he undertook, working hard for little reward. Having no ambition but to serve well, he lived to serve.

Some would say that his hobbies were lawn-tennis and gardening. But truly his College was his hobby and his absorbing pursuit. His home and garden were places of renewal in the companionship of his wife, his two sons and his daughter. Is it possible that he shared with them, as he did with me, in the year 1944, the discovery that that number is just $3^5 \times 2^3$? Ebenezer Cunningham

Dr. M. A. Whiteley, O.B.E.

Martha Annie Whiteley was born on November 11, 1866, and received her early scientific training at Royal Holloway College, London, where she graduated in 1890. During the following twelve years she held appointments as science mistress at Wimbledon High School, lecturer in science at St. Gabriel's College, Camberwell, and lecturer in physical chemistry at Royal Holloway College. During the last few years of this period, from 1898, she also carried out part-time research at the Royal College of Science, and in 1902 she obtained the D.Sc. degree of the University of London (her examiners at the oral examination being Ramsay and Frankland), and in 1903 the diploma of associateship of the Royal College of Science. In the following year Tilden appointed her to be a teaching scholar on the staff of the Royal College of Science, and she was promoted assistant in 1905, demonstrator in 1908 (by which time the College had become part of the newly constituted Imperial College of Science and Technology), lecturer in 1914, and assistant professor of organic chemistry in 1920.

Her first paper, in 1900, on "The Oxime of Mesoxamide", set the pattern of her research activities on derivatives of malonic acid and barbituric acid. During the First World War, her specialized knowledge in this field enabled her to play an important part in the development of methods for the synthesis

of urgently needed drugs, and she also carried out investigations on lachrymatory war gases; for these services she was made O.B.E. She will, however, be particularly remembered for her teaching, which she greatly enjoyed. At the time of her retirement from Imperial College in 1934 she said, "When I first came to the College in 1898 I little thought to find my life's work here as a member of the teaching staff, but my love for teaching has made it seem all too short. No one who has not passed through an experience such as mine can understand the fascination which is involved in the constantly changing types of students and the human interest attaching to them". She took a particular interest in the women students, and was largely responsible for the foundation, in 1912, of the Imperial College Women's Association, of which she was president for many years. Earlier (1904–8) she had taken a leading part in efforts, unsuccessful at the time, to secure the admission of women to fellowship of the Chemical Society; it was highly appropriate that in due course she should become the first woman to be elected to its Council (1928–31).

During the many years she spent at Imperial College, Dr. Whiteley formed a connexion with "Thorpe's Dictionary of Applied Chemistry" which in later years was to become a source of great happiness to her. She had been associated with Sir Edward Thorpe and with Sir Jocelyn Thorpe in the production of the second and third editions, and after her retirement in 1934 she continued to work on supplementary volumes and on the preparation of the fourth edition, the first volume of which appeared in 1937. After the death of Sir Jocelyn in 1940, she became editor-in-chief, and despite inevitable war-time restrictions and personal difficulties, which included the destruction of her home in an air-raid, the work went on. In the years since the War, her physical health deteriorated, but her mind remained as clear and alert as of old, and with her indomitable will she continued to edit scripts and to read every word of galley and page-proof; it was rarely that an error escaped her. Volume XI, which, apart from a general index, was the last of the fourth edition, appeared in 1954, and the completion of this considerable undertaking gave her much satisfaction, inevitably tinged with some sadness. Her health now became progressively worse, and she died on May 24, 1956, in her ninetieth year.

Martha Whiteley's concepts of duty and service, and her way of life, were sustained by her Christian beliefs; her memorial is in the respect and affection which she engendered in generations of students, colleagues and friends. L. N. Owen

NEWS and VIEWS

Royal Meteorological Society: Napier Shaw Memorial Prize

At the meeting of the Royal Meteorological Society on June 20 the president, Dr. R. C. Sutcliffe, announced that the first award of the Napier Shaw Memorial Prize of the Royal Meteorological Office had been made to Dr. Norman A. Phillips, of the Institute for Advanced Study, Princeton, for his paper, "The General Circulation of the Atmosphere: a Numerical Experiment", which was published in the April issue of the Society's *Quarterly Journal*. This Prize has been established as a result of an appeal to the members of the Royal Meteorological Society and to scientific instrument manufacturers for a memorial fund to commemorate the unique position achieved in meteorology by Sir Napier Shaw, the centenary of whose birth fell on March 4, 1954. It was decided to use this fund for the regular award by competition every two or three years of a Napier Shaw Memorial Prize of £100 for original essays on meteorological topics. The first competition was announced in 1954, the topic selected being "The Energetics of the General Circulation", and entries were open to anyone without restriction of nationality.

Chemistry at Hull: Prof. N. B. Chapman

With the appointment of Prof. Brynmor Jones to the vice-chancellorship of the University of Hull (see *Nature* of January 21, p. 116), the G. F. Grant chair of chemistry at Hull which he has vacated has been filled by Dr. Norman B. Chapman, reader in chemistry in the University of Southampton. Dr. Chapman was educated at the Holgate Grammar School, Barnsley, and Magdalene College, Cambridge, where he was successively scholar, research student and bye-Fellow, being University demonstrator during 1945–46. While at Cambridge he carried out research on oxidation by peroxidase systems, and on chemical warfare and anti-malarial agents. Early in 1947 he went to Southampton, becoming successively lecturer in organic chemistry, senior lecturer and, in 1955, reader. In Southampton he has built up a strong school of research with two principal lines of work: a study of the kinetics of many organic reactions, including the substitution of halogens in aromatic and heterocyclic ring systems; and the synthesis of nitrogen-substituted halogeno-ethylamines, histamine derivatives, and other substances of potential pharmacological importance. He has a wide knowledge of physical as well as of organic chemistry, and among many other interests are cricket, rugby football and opera. The warmest wishes of his many friends at Southampton and elsewhere go with him and his wife to Hull.

Chief Colourist of the Dyestuffs Division, Imperial Chemical Industries, Ltd.: Dr. T. Vickerstaff

Dr. T. Vickerstaff has been appointed chief colourist of the Dyestuffs Division of Imperial Chemical Industries, Ltd., in succession to Mr. G. O. Mitchell, who has retired after thirty-seven years of service with the company. After leaving the University of Manchester, Dr. Vickerstaff joined Imperial Chemical Industries, Ltd., in 1935, and was at first engaged in work on problems of dyeing wool, which was carried out in the University of Leeds. This was followed by a short period at the Huddersfield Works of the Dyestuffs Division, and then in 1937 he was transferred to the Dyehouse Department at Hexagon House, which is the administrative headquarters of the Division in Blackley, Manchester. He became closely associated with the work of the newly formed Dyeing Research Section of the Dyehouse Department and was appointed head of the Section in 1942. During this period he made valuable contributions to the study of colorimetry and became a leading

member of the Colour Group of the Physical Society. Overlapping with his work on colorimetry he has made a number of fundamental studies of the physical chemistry of dyeing. His text-book, "The Physical Chemistry of Dyeing", is now in its second edition, and moves are afoot to translate it into German and Japanese. In 1942 Dr. Vickerstaff was awarded the Research Medal of the Society of Dyers and Colourists as senior author of the paper "The Dyeing of Acetate Rayon with Dispersed Dyes". He was appointed an assistant chief colourist of the Dyestuffs Division in 1949.

Colleges of Advanced Technology

An extensive building programme, to start next year, in connexion with technical studies in the universities, estimated to cost about £4,500,000, was announced during a debate on technical education by Mr. R. A. Butler, Lord Privy Seal, in the House of Commons on June 21. The new buildings are to be dedicated not only to engineering and branches of technology, but also to basic sciences, especially physics and chemistry. The sum announced represents only the contribution of the Exchequer, and does not include other sums which might be contributed by industry or by the universities themselves. These colleges are in future to be designated colleges of advanced technology, and conditions for such designation were circulated on June 21 by Sir David Eccles, Minister of Education, to local authorities. The circular outlines the present organization of technical colleges, and suggests how each kind of college can best contribute to the Government's five-year plan for technical education. Regional co-ordination is essential to the success of this policy, and the Minister asks the local education authorities to co-operate fully with one another. He considers it important that the smaller technical colleges should develop as speedily as possible into colleges of technology.

In the House of Commons on June 21, the Minister named those colleges which will be recognized as advanced colleges of technology. They are: Birmingham College of Technology, Bradford Technical College, Cardiff College of Technology and Commerce, Loughborough College of Technology, The Royal Technical College, Salford, The Battersea Polytechnic, London, The Chelsea Polytechnic, London, The Northampton Polytechnic, London. Some of these colleges do not fulfil the necessary conditions at present, but it is hoped that they will do so in the near future. Among the conditions for designation as a college of advanced technology are strong direct representation of industry, besides representatives of local education authorities, universities and professional technological interests. Teaching conditions must approximate to those of equivalent standard at universities, and the staff must have opportunities for research and consulting work. The Minister lays considerable stress on the provision of residential accommodation. The circular which the Minister has sent to local authorities also describes the three kinds of existing technological colleges, referring to them as local, area and regional colleges.

Frederick D. Edwards Trust for Financial Help for Technical Students

Mr. F. D. Edwards, founder and managing director of Edwards High Vacuum, Ltd., has recently formed the Frederick D. Edwards Scholarship Trust, the purpose of which is to give financial aid to technical students pursuing or intending to pursue a course of training in science and technology. The capital of the Trust is £12,000, and Mr. Edwards has stipulated that the whole of this and its associated income must be spent within ten years. Otherwise, the trustees have a completely free hand to dispose of the money as scholarships, bursaries, prizes, small-scale grants, or in any other way they think fit. Although three institutions are specifically mentioned in the Trust deed—the Northampton Polytechnic, the National College of Instrument Technology and the Crawley Technical College—a student at any institution "giving training courses or facilities for research in any branch of science or technology" is eligible. Inquiries about the Trust and applications for grants should be made through college principals to either of the two trustees: Mr. F. S. B. Murrells (director and secretary of Edwards High Vacuum, Ltd.), at Tresco, Nevill Court, Tunbridge Wells, Kent; and Mr. A. J. Philpot (retiring director of the British Scientific Instrument Research Association), at Cranley, Bressey Grove, London, E.18.

Rain-making in Tanganyika

In a written answer in the House of Commons on May 31, Mr. Lennox-Boyd, Secretary of State for the Colonies, said that because of partial failure of the seasonal rains, the level of the reservoir at the Kazima Dam, which provides Tabora, the railway junction and administrative centre in the Western Province of Tanganyika, was dangerously low at the end of March. A new 'cloud-seeding' technique, involving the use of 2-in. naval rockets, modified to incorporate particles of sea salt, which had been evolved by the East African Meteorological Department in conjunction with the Admiralty and the Ministry of Supply, was accordingly tried out, and thirty-seven such rockets were fired between April 12 and May 2. Under the conditions prevailing, the best results were obtained when the rockets burst at about 3,000 ft., and 1·5 miles downwind of the catchment area of the Kazima Dam. The results are still being studied, but there was definite evidence that under suitable conditions cloud-seeding produces rain. A significant feature of the experiments was the repeated occurrence of rain over the catchment area some 12 minutes after seeding, and at the end of the experiments the level of the reservoir had risen by 2·5 inches, despite a daily consumption of 250,000 gallons and a high loss through evaporation. Rainfall in the catchment area during April was about one to one and a half inches higher than that measured at stations near but outside the catchment area.

The Houldsworth School of Applied Science, Leeds

The Council of the University of Leeds has approved a re-organization of the Department of Coal Gas and Fuel Industries with Metallurgy and Chemical Engineering. Under this re-organization the present Department will be replaced by a School, to be called "The Houldsworth School of Applied Science". Sir Hubert Houldsworth, the late pro-chancellor of the University, had been for some years a member of the staff of this Department, and through his work as fuel controller and with the National Coal Board was very familiar with its activities. The Houldsworth School of Applied Science will be constituted of three Departments: Gas Engineering and General Fuel Science with Ceramics, directed by the Livesey professor, Prof.

A. L. Roberts; Chemical Engineering, directed by the Brotherton professor—a newly established chair; Metallurgy, directed by the reader in metallurgy, Dr. N. J. Petch.

The European Coal and Steel Community

THE Broadsheet issued by Political and Economic Planning on the "European Coal and Steel Community" (No. 389. November 21, 1955) is of some current interest in view of the possibility that institutions which have served the Community well so far may be taken as a model for the development of the peaceful uses of atomic energy. The Treaty establishing the Community was signed on April 18, 1951, and the Broadsheet briefly describes the evolution of what is the only truly supra-national organization in Western Europe which seeks to unify markets and control basic resources by eliminating six obstacles: customs duties and quantitative restrictions on coal and steel movements between the member countries; discriminatory transport rates; price discrimination for domestic and export sales within the Community area; cartels and agreements on restraint of trade; government subsidies; and government control of prices. The organization for achieving these objectives consists of an executive body, the High Authority, to establish and maintain the common market and answerable to the Common Assembly, a Consultative Committee, a Council of Ministers and a Court of Justice. The development of the Community has already passed through what may be called the opinion-forming stage and has now entered a second phase of long-term policies, European rather than national in character. As an economic experiment, the Community has been a success so far as the six countries are concerned, and Britain set up in July 1952 a joint committee for the exchange of full information of common interest and has maintained cordial relations with the High Authority ever since. What happens next in the Community depends on political rather than economic policies, and the Broadsheet points out that the view is widely held that progress is most likely in the integration of the production of atomic energy but that rejection of the European Defence Community has left it high and dry as the sole trophy of the federalist movement.

U.S. National Science Foundation: Senior Postdoctoral Fellowships

APPLICATIONS are invited for the second group of senior postdoctoral fellowships to be awarded by the U.S. National Science Foundation during the current calendar year. These will be awarded in mathematical, physical, medical, biological, engineering and other sciences, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and areas of convergence between the natural and social sciences. To be eligible for these awards, candidates must be citizens of the United States. Annual stipends of 2,000–10,000 dollars, adjusted to match as closely as feasible the regular salaries of the award recipients, may be applied toward study or research in an accredited non-profit institution of higher learning in the United States or abroad. A limited allowance to aid in defraying costs of travel for a Fellow and his dependants will also be available. Further details can be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

Review of Czekoslovak Medicine

THE quarterly journal *Review of Czekoslovak Medicine* (1, No. 1; 1955. Praha: Státní Zdravotnické Nakladatelství (Sokolská tr. 31)), which is printed in English only, fulfils, to quote the words of its introductory article by B. Špaček, vice-chairman of the Scientific Council of the Czechoslovak Ministry of Health, "a natural and earnest desire of all Czekoslovak medical scientists to bring their work before a truly international audience. Czekoslovak physicians have regretted that, no matter how significant or valuable their work, it has for the most part, because of language difficulties, been insufficiently known in foreign countries . . ." and "too often . . . the priority of outstanding work by Czekoslovak investigators" has been "denied, incorrectly, by scientists of other nations. . . ." This introductory article then mentions Czech investigators whose work is insufficiently known outside their own country and explains that "Czekoslovak science passed through its most arduous trials during the Hitler occupation", when its universities were closed and its workers were persecuted. "Only with the establishment of our People's Democracy, which is building socialism on a scientific basis, is a foresighted policy being pursued . . ." and "publishing facilities . . . have been enlarged . . ." until nowadays "fifty medical and health journals are published". The article concludes with an appeal for a friendly reception of this new journal, which is "an expression of our deep conviction that mutual understanding can bring about both lasting peace between the nations and the prosperity of all mankind".

The rest of the first issue of the journal contains scientific contributions, with annotations, abstracts and reviews. The leading article, by F. Burian, describes the development of plastic surgery in Czechoslovakia. Other contributions are: research on the pathophysiology and some symptoms of hysteria (J. Černáček); sodium citrate—one of the main causes of cardiac overloading and failure in rapid blood transfusion (P. Firt and L. Hejhal), and ascorbigen—the bound form of ascorbic acid (Ž. Procházka). An annotation by K. Hübschmann deals with the venereal disease campaign in Czechoslovakia, and another, by F. Démant and T. Prehop, with acute infectious hepatitis. A note by the editor points out that references appended to the individual papers quote only the work of Soviet, Czech or Slovak authors, this being an effort to economize space and to acquaint English-speaking readers with work "less easily accessible to them"; but if it "should prove desirable to quote fully all work cited", an effort will be made to do this in future issues. The subtitle of the journal is "Journal of the Czekoslovak J. E. Purkyně Medical Association" and this commemorates one of the world's very great histologists and physiologists.

British Hat and Allied Feltmakers Research Association: Report for 1955

THE eighth annual report of the Director of Research of the British Hat and Allied Feltmakers Research Association, covering the year ended August 1955 (pp. 23; from the Association, Manchester, 1955), notes that, besides continuing work on the technology of carrotting of fur, a better picture of the initial reactions in the carrotting process appears to be obtained by studying the absorption of mercury from solutions of mercuric

sulphate in sulphuric acid by animal and man-made protein fibres, as there is no incipient decomposition, such as occurs with nitric acid solutions. Line tracings of magnified fibres have given an adequate demonstration of the theory that directional felting is to be attributed to orientation of fibre units in the form of loops, in a preferred direction at right angles to that of the impulsive forces, and the anisotropic properties of felt produced by directional felting accord with this conception. A study of the physical and chemical properties of different samples and grades of lac has been commenced, and the foundations have been laid for a detailed study of wool hardening. The examination of the fastness properties of various classes of dyestuffs for fur felt indicates that the wet fastness on fur felt tends to be lower than that listed by the manufacturers for wool. The metal-complex type of dyestuff appears to possess excellent fastness properties, but in the laboratory attempts to apply them satisfactorily without undue degradation failed. Practical trials have been made of the influence of temperature in dyeing fur felt in the cone type of machine and in the free circulatory type, while studies of the effect of increases in acidity and temperature of treatment of a series of non-mercuric carrotted furs, prepared with a hydrogen peroxide–nitric acid carrotting agent, showed losses of protein remarkably similar to those for mercuric carrotted furs. Interest in the application of showerproofing agents and work on the assessment of physical properties and dimensional characteristics of felt were maintained during the year under report. An attempt is being made to separate compression from felting by studying a series of experimentally compressed felts, and an apparatus has been constructed for giving a non-destructive measure of air-permeability of wool hoods.

Computing Service at the Franklin Institute, Philadelphia

It is reported in the *Journal of the Franklin Institute* (**261**, 384; March 1956) that a contract has been signed for the installation of a complete UNIVAC computing centre and an integrated computation exhibit in the Franklin Institute in Philadelphia. The centre, which will be operated by Institute personnel under the supervision of Mr. D. Houghton, section chief of the Analysis Section, Division of Electrical Engineering, of the Institute, will be the largest of its kind for public use and the first to be installed in a private institution. The computations to be performed will be either for the Institute's laboratories, in which case they will relate to scientific or engineering problems, or for the public. The exhibition section will portray the historical evolution of the art of computation from the earliest calculating machine, the abacus, to the most modern electronic computer, and a guide will explain in simple and non-technical language how the ultra-modern devices operate. UNIVAC large-scale computer systems, the product of the Remington Rand UNIVAC Division of the Sperry Rand Corporation, are in use in several industrial and government institutions in the United States and their particular value lies in the great speed of operation, the large amount of information digested and the accuracy of the results obtained because of the automatic self-checking features. In the UNIVAC computer, for example, the high-speed printer sets down the final results at the rate of 78,000 characters a minute.

Sondes Place Research Institute

The Sondes Place Research Institute has published an attractive illustrated booklet (pp. 16; from the Institute, Dorking, Surrey; 1955) describing the organization and services for sponsored research and development in chemistry, chemical engineering and mechanical engineering offered by the Institute. Some twelve hundred problems have been handled by the Institute during its first seven years, and nearly three thousand copies of its occasional bulletin, entitled "Report", are distributed in thirty-nine countries throughout the world, each issue being devoted to a single subject of general interest to industrialists and directors of research. The Institute has developed from a consulting chemical and chemical engineering practice founded in London in 1936 and incorporated as a limited company in 1947, when the present premises on the outskirts of Dorking were acquired. These include laboratories for the chemical, chemical engineering and mechanical engineering departments, a library, stores, administrative offices and drawing office. The pilot-plant house at Sondes Place has a floor area of 2,000 sq. ft., with an annexe of 700 sq. ft. for special investigations, while a further area of 1,680 sq. ft. is now available in the outbuildings of the adjacent property of Milton Heath. The services offered include technical and economic assessment of projects, laboratory research, the development of pilot plant, and the design of full-scale plant.

Museum of Applied Arts and Sciences, Sydney: Annual Report for 1954

The annual report for 1954 of the Museum of Applied Arts and Sciences, Sydney, outlines the requirements and hopes for the future of this progressive museum—probably the foremost of its kind in the southern hemisphere. Urgent needs include a new Spitz planetarium and an orrery, while the long-term policy makes provision for a new site and a new building of some 200,000 sq. ft. to replace the present one of about 27,000 sq. ft. The report states that many valuable and historic exhibits are now confined to storage, and that the limited accommodation for the public makes it almost impossible at peak periods for the exhibits to be appreciated intelligently. Exhibition activities include the display of an important collection of footwear, musical boxes and gramophones, a modern television unit and a transparent plastic woman. As usual, many scientific reports on particular problems, often of national importance, have been prepared by members of the staff.

Museum of Applied Science, Victoria: Report for 1953–54

The report for 1953–54 of the Museum of Applied Science, Victoria (pp. 15; from the Museum, Melbourne, 1955), indicates that the outstanding event was the special display arranged to commemorate the fiftieth anniversary of the achievement of powered flight. The display was in a chronological sequence and included numerous charts on the performance of aircraft, photographs, documents and relics. The exhibition included about ninety different aircraft models ranging from the age of the kite and glider to the modern period of the jet and rocket. The Fleet Air Arm displayed a Sea Fury outside the building. It is also reported that a radiocarbon dating service with the necessary apparatus is being set up by the Museum.

Turbulence above the Ozone Layer

In a paper dealing with turbulence above the ozone layer (*J. Brit. Interplanetary Soc.*, **15**, 1; Jan.–Feb. 1956), Alan E. Slater gives a very comprehensive account of the subject, leading to the conclusion that the region of the atmosphere from 50 to 80 km. may not be turbulent, as is usually accepted. Discussing temperature distribution with height, patterns of convection and speed of vertical currents, he shows that there is no consistent evidence for instability in the upper regions of the atmosphere from 50 to 80 km. In addition, even if turbulence exists there, it is doubtful whether the vertical currents would be strong enough to affect significantly the passage of a winged vehicle through them. The discussion of the probable pattern of convection currents leads to the conclusion that uniform heating should give a regular pattern with the spacing between up-currents equal to two and a half times the thickness of the convection layer. Changes of wind with height in the region between 50 and 80 km. would cause the cells to be distorted and drawn out lengthwise in the direction of the wind shear, and it would be possible for a vessel flying parallel to the shear to remain in an up-current or a down-current for a long time. A discussion of the speed of the vertical currents leads to the conclusion that a winged vessel travelling at 6 km./sec. would not be affected to any noticeable extent unless the currents had a speed of several hundred metres a second. A rough calculation shows that for an up-current to reach a speed of 100 m./sec. after rising through 30 km., it would be necessary for it to be and to remain about 10 deg. C. hotter than its surroundings. It is considered unlikely that such a large temperature excess exists, and the conclusion is that there is some doubt whether the vertical currents are able to affect significantly the passage of a winged vehicle through them.

Diagnosis of Amoebiasis

An illustrated article on the diagnosis of amoebiasis, by Sir Philip Manson-Bahr (*Central African J. Medicine*, **1**, No. 6; November 1955), is one of great interest to all those who have to undertake the difficult task of laboratory diagnosis of this form of human dysentery. It explains, in simple language, all the pitfalls and difficulties that await the microscopist whose duty it is to decide whether or not *Entamoeba histolytica* or its cysts are present in the material he has to examine —material which may come from the intestine, the liver, the brain or from other organs. A useful plate gives line-drawings of most of the objects that may resemble the cysts of *E. histolytica*, and other drawings show the harmless amoebae which may be present on human faeces. This is, in fact, just the kind of article that the diagnostician needs, and it gives him much detailed information that text-books omit.

Sitka Spruce and Douglas Fir in America and Great Britain

A considerable proportion of the plantations undertaken in Britain by the Forestry Commission during its early years was made with Sitka spruce and Douglas fir, chiefly the former. These conifer species come from the Pacific coast of North America. In order to make a comparison of the growth of these species in their natural habitat with that in Britain, Mr. R. F. Wood, an officer of the Forestry Commission, with the help of a Nuffield travelling scholarship, paid a visit to the forests of British Columbia and the neighbouring territories to carry out field studies, and has recorded his investigations in Forestry Commission Bulletin No. 25, "Studies of North-West American Forests in relation to Sylviculture in Great Britain" (pp. 43+35 photographs. London: H.M.S.O., 1955; 6*s.* net). A study was made of climatic zones comparatively similar to those in Great Britain from the point of view of seed collection for use in Britain. This referred more especially to the Douglas fir, which even in coastal forests occupies areas that are far more continental than those in Britain. But the results of the study showed that we still lack first-hand evidence of the advantages to be gained from close matching, and perhaps there are hints that flexibility in Douglas fir is most likely to be found in regions one step removed from the most oceanic conditions. This does not apply to the Sitka spruce, which is largely confined to regions of some oceanity and therefore more comparable to Great Britain.

Identification of an Endotrophic Mycorrhiza

An account has been given by B. Mosse (*Ann. Bot.*, N.S., **20**, 78, 349; 1956) of the identification of a hitherto undescribed species of *Endogone* which she found in organic connexion with mycorrhizal strawberry roots grown in pots in a greenhouse. By inoculating sterilized soil with these fructifications and with spores excised from them, it was possible to produce typical vesicular-arbuscular infections in strawberry, apple and a number of other plants. These inoculation experiments constitute the first record of the establishment of endotrophic mycorrhizal infection in plants raised under aseptic conditions.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division: J. Bowden (senior specialist, Department of Agriculture, Gold Coast), principal specialist, Department of Agriculture, Gold Coast; H. A. Darby and R. E. Osborne (senior agricultural officers, Jamica), chief agricultural officers, Jamaica; D. F. Edwards and D. R. Goodrich (agricultural officers, Gold Coast), senior agricultural officers, Gold Coast; E. J. Gregory (deputy director of agriculture, Jamaica), assistant director of agriculture, Northern Region, Nigeria; F. E. Luscombe (agricultural officer, Tanganyika), chief agricultural officer, Nyasaland; E. R. H. Martin, A. G. Naylor, R. K. Richardson and L. K. A. Swaby (agricultural officers, Jamaica), senior agricultural officers, Jamaica; W. B. Collins (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; M. Dinning and D. M. Duggie (assistant conservators of forests, Gold Coast), senior assistant conservators of forests, Gold Coast; G. J. Leggat (assistant conservator of forests, Uganda), conservator of forests, Uganda; E. W. March (conservator of forests, Eastern Region, Nigeria), chief conservator of forests, Eastern Region, Nigeria; G. Webster (assistant conservator of forests, Uganda), conservator of forests, Uganda; N. J. Guest (geologist, Geological Survey Department, Tanganyika), senior geologist, Geological Survey Department, Fiji; B. O. L. Duke (medical research officer, grade III, British Cameroons), medical research officer, grade I, West African Council for Medical Research, Western Region, Nigeria; A. M. Orhan (veterinary officer, class II, Cyprus), veterinary officer, class I, Cyprus; H. Batten (senior pharmacist, Western Region, Nigeria), chief pharmacist, Western Region, Nigeria; D. R. Glendinning,

scientific officer, plant breeder, West African Cacao Research Institute, Gold Coast; D. Dow, assistant cacao propagation officer, Jamaica; M. Sanders and B. M. Savory, assistant conservators of forests, Northern Rhodesia; A. E. Wright, geologist, Tanganyika; D. G. Godfrey, scientific officer (parasitologist), West African Institute for Trypanosomiasis Research, Nigeria; N. A. Hancock, veterinary parasitologist, Northern Region, Nigeria; R. M. Mackenzie, veterinary officer, Eastern Region, Nigeria; B. A. V. Peacock, curator of museums, Federation of Malaya.

Plastic Theory of Engineering Structures: Symposium in Cambridge

A SYMPOSIUM on "The Plastic Theory of Structures" will be held in the Engineering Department of the University of Cambridge during September 18–21. For twenty years a research team under the direction of Prof. J. F. Baker has been at work, at first in Bristol and since 1943 in Cambridge, investigating the behaviour of steel structures in the plastic range and developing a plastic method of designing structures. The stage has now been reached where a new branch of the theory of structures of considerable educational value is available together with a practical method of design of wide application. The symposium is therefore designed to bring together those who teach engineering and those who are practising members of the profession. The fee for the symposium is ten guineas, which will cover all living expenses, a preliminary set of the papers, and a final set of reprints, including the discussions. Further information can be obtained from the Secretary of the Department of Engineering, Trumpington Street, Cambridge.

Dilogarithms and Related Functions

MR. L. LEWIN, 33 Wellington Road, Enfield, Middlesex, writes: "I am in the course of preparing the manuscript for a book on dilogarithms and related functions and would appreciate the opportunity to appeal to readers who have encountered these functions in the course of their work. Any information on their occurrence in practical problems, and which I could incorporate, with due acknowledgment, would be welcome. The functions concerned arise from the series $\sum_{1}^{\infty} x^n/n^r$ and the integral $\int \log^n(x)\, dx/(1+x)$, and include the log sine integral".

The Night Sky in July

NEW moon occurs on July 8d. 04h. 37m., U.T., and full moon on July 22d. 21h. 29m. The following conjunctions with the Moon take place: July 6d. 17h., Venus 3° S.; July 7d. 05h., Mercury 2° N.; July 11d. 07h., Jupiter 7° N.; July 17d. 15h., Saturn 11° N.; July 27d. 14h., Mars 11° S. In addition to these conjunctions with the Moon, Jupiter is in conjunction with Regulus on July 2d. 09h., Jupiter being 0·6° N., and Mercury is in conjunction with Regulus on July 3d. 20h., Mercury 3·3° N.; also, on July 3d. 20h., Mercury is in conjunction with Venus, Mercury 3·3° N. Mercury rises at 2h. 40m., 3h. 30m. and 4h. 45m. on July 1, 15 and 31, respectively, but is too close to the Sun for favourable observation. Venus rises at 3h. 20m., 2h. 20m. and 1h. 40m. at the beginning, middle and end of the month, respectively. The close approach of Regulus, Jupiter, Venus and Mercury (though Mercury may be difficult to see) on July 3 should be an interesting phenomenon. Mars rises at 23h. 20m., 22h. 40m. and 21h. 50m. on July 1, 15 and 31, respectively, and is visible during the later hours of the night and the morning hours before twilight. Its eastward movement in Aquarius is easily detected, though it lies too low for good observation. Jupiter sets at 22h. 35m. and 21h. 45m. on July 1 and 15, respectively, but later in the month is too close to the Sun for favourable observation. Saturn lies low in the constellation Libra and towards the end of the month is a little south of γ Librae. It sets at 1h. 30m., 0h. 30m. and 23h. 30m. on July 1, 15 and 31, respectively. Occultations of stars brighter than magnitude 6 are limited to c Cap., magnitude 5·3, which disappears on July 25d. 0h. 05m., observation being made at Greenwich. The Earth is in aphelion on July 5d. 01h., its distance from the Sun being then 94½ million miles.

Announcements

THE University of Minnesota has recently made the Elvin Charles Stakman Award to Prof. W. L. Waterhouse, of the University of Sydney. This award consists of a medal, a scroll and a nominal monetary grant, and has been given for outstanding contributions to the biology of the cereal rusts and to basic concepts useful in the production of disease-resistant plants.

THE title of reader in physical chemistry in the University of London has been conferred on Dr. J. A. Kitchener, and that of reader in acoustics in the University of London on Dr. R. W. B. Stephens, both being in respect of posts held at the Imperial College of Science and Technology.

THE following awards have been made by the Lady Tata Memorial Fund for research on leukæmia and allied diseases during the academic year 1956–57: *Grants for Research Expenses*, Dr. Morten Simensen (Fibiger Laboratories, Copenhagen) and Prof. B. Thorell (Caroline Institute, Stockholm); *Scholarships* (*whole-time or part-time*), Dr. Giuseppe Marinone (University Medical Clinic, Pavia) and Dr. A. J. Therkelsen (Institute for General Pathology, University of Aarhus). Various awards made to the following in previous years (see *Nature*, **175**, 1067; 1955) have been renewed for a further year: Dr. J. Kieler, Dr. J. Ringsted and Dr. J. Rygaard (Copenhagen); Dr. J. Nordmann (Paris); Dr. A. Sreenivasan (Bombay); Prof. H. G. Teir (Helsinki); Dr. C. G. V. Wasastjerna (Vasa, Finland); Dr. M. Seligmann (Paris); and Dr. Alice Stewart (Oxford).

THE seventh Canadian High Polymer Forum will be held at the Guildwood Inn, Sarnia, Ontario (postal address: P.O. Box 912, Point Edward, Ont.), during November 8–9. The Forum is sponsored by the National Research Council of Canada and by the Chemical Institute of Canada and is devoted to all aspects of polymer science. The guest speaker will be Prof. J. J. Hermans, of the University of Leyden. Abstracts and titles of papers should be sent by August 31 to the programme chairman, Dr. D. G. Ivey, Department of Physics, University of Toronto, Toronto 5, Ontario. All other communications regarding the Forum should be addressed to the chairman, Dr. H. Leverne Williams, Polymer Corporation, Ltd., Sarnia, Ontario.

ERRATUM. In a communication entitled "Muscular Dystrophy of Beef Cattle and Unsaturated Fats" in *Nature* of April 28, p. 792, the heading for col. 3 of Table 1 should read "Mean tocopherol content of milk fat (μgm./gm.)".

IMPROVEMENTS IN SEISMIC PROSPECTING

A GEOPHYSICAL Discussion of the Royal Astronomical Society was held at Burlington House, London, on April 20, when three papers were read on "Improvements in Seismic Prospecting". Mr. B. C. Browne (University of Cambridge) was in the chair.

The first communication, by F. W. Hales (Seismograph Service, Ltd.), dealt with the development and applications of continuous velocity logging. With the trend towards greater resolution and more detailed interpretations of seismic data, the need for a continuous record of seismic velocity against depth has become desirable. The continuous velocity logger has been developed to fulfil this requirement, and it has already demonstrated its ability to provide data on velocity and the delineation of reflecting horizons to such a degree as to make it a useful exploration tool.

The borehole instrument consists of an ultrasonic pulse generator and receiver suspended by a cable and separated from one another by a length of acoustic insulator. The pulses are radiated at a frequency of twenty per second, and both the times of transmission and reception are recorded at the surface. The time-delay, recorded continuously as a function of depth, is a direct measure of the seismic velocity in the materials forming the borehole walls. In addition, the recorder performs a mechanical integration of this velocity profile which gives the total time of travel from the surface to the depth of the instrument. In practice, the recorder-trace is calibrated by directly observing the time of travel from a surface shock by means of a pressure-sensitive detector fastened to the instrument.

It soon became apparent when using the instrument that it provided a picture of the lithology of the borehole walls as it concerns the seismologist, since the record demonstrated discontinuities in the acoustic impedance of the formations traversed. Hitherto, the geological log has provided a guide to the interpretation of seismic data, and the seismologist has naturally tried to associate reflecting surfaces with geological discontinuities. The continuous velocity logger reveals many discontinuities unsuspected by the geologist. From comparing such velocity profiles with the results of seismic reflexion shooting, the following observations have been made: (1) There are as many interfaces where there is a decrease of velocity with depth as there are where the reverse is true, and reflexions may originate at either type of interface. (2) Reflexions frequently originate from a group of thin layers with alternating strata of high and low velocity, the reflected signal being synthesized from the waves produced at each bed; this particular type of reflexion delineates a zone rather than a discrete interface. (3) Geological divisions established from palæontological considerations are frequently not characterized by any marked discontinuity in acoustic impedance.

Difficulties in the interpretation of seismic records caused by multiple reflexion have also been resolved by the synthesis of seismic data from the continuous velocity log. The details of this method of record synthesis have been given by Peterson, Fillippone and Coker[1]. They show that the reflexion coefficient may be approximately related to the incremental change in the logarithm of the acoustic impedance. If the assumption is made that the rock density and velocity are related by a simple power law, the reflexion coefficients may be determined directly from the continuous velocity log.

The derived record of acoustic impedance is used for calculating the amplitudes of reflected pulses, which are proportional to the reflexion coefficients; and after passing through shaping filters which simulate the absorption in the Earth and also through geophone and amplifier equivalent circuits, the recorded output has the nature of the seismic record which would be expected from the disposition of reflecting layers.

The log of interval velocity is more directly associated with the physics of the formation of layers rather than their chemistry, and it is therefore of great value to the geologist wishing to trace the lithology of a borehole. When used in a number of boreholes in the same district, it has often been possible to correlate the profiles from the separate holes. Unlike resistivity measurements, the measurements are not seriously affected by the use of highly saline drilling fluids. It has also proved possible to correlate velocity and porosity measurements within the same formation. In general, layers with low density (determined in the laboratory) have low velocities.

Work is also in progress which appears to demonstrate that when continuous velocity logging is supplemented with conventional radioactivity and electrical logs, it is possible to differentiate in some instances between the presence of gas, oil and water. In his paper, Mr. Hales showed some continuous velocity records obtained in the wells of the D'Arcy Exploration Co., Ltd., and the Compagnie d'Exploration Petrolière.

Discussing the paper, the chairman asked what ultrasonic frequency is used and whether the observed velocities are dependent on the signal frequency; Mr. P. G. Lazenby, who was joint author of the paper, said that 50 kc./s. is the pulse frequency, but no measurements have been made on the frequency dependence of velocity. Dr. T. F. Gaskell commented that measurements that have been made on coal showed no change of seismic velocity with frequency. When asked if the mud path would greatly influence the travel time, Mr. Hales said that it has been discussed, and an improved instrument is to be made having two receivers.

The second paper, read by Dr. R. Raitt, of the Scripps Institution of Oceanography, La Jolla, California, described the seismic refraction work that has been done in the equatorial Pacific Ocean on the Mid-Pacific and Capricorn Expeditions in 1950 and 1952–53, respectively. Some improvements have been made in the utilization of explosive energy for seismic waves and decreasing the noise picked up in the hydrophones. When the shot is fired at a depth corresponding to half a wave-length at the bubble pulse frequency and the hydrophones are suspended at a similar depth in a state of neutral buoyancy, the following relationship is found between the average maximum range at which signals can be observed (Δ in km.) and the shot weight (W in lb.)

$$\Delta = 7\ W^{1/3}$$

There was a wide scatter from this formula; signals have been received from an 80-lb. shot at 190 km.

In making measurements with two ships, the split-profile type of record was most often taken; the firing ship drops charges continuously and steers an approximately straight course, passing the stationary recording ship and its hydrophones at the middle of its run. The reverse profile technique was also used occasionally; but owing to drift and navigational difficulties the full value of a reverse profile was never completely realized. For the interpretation of the seismic refraction data, the assumptions of constant-velocity layers, the velocity of which successively increased with depth, were used. In addition to the topmost layers of sediment, three distinct velocity layers were observed having velocities of 4·0–6·0, 6·5–7·0 and 8–8·5 km./sec., respectively. Changes in these velocities in a lateral direction were observed; but whether these are always real is uncertain. The velocity in the upper sediments was not determined by refraction; but a few reflexion measurements gave an average at 2·15 km./sec.

Dr. Raitt presented a slide showing the thickness of the crust defined by the depth at which the velocity reaches 8 km./sec. as found by several workers on the continents and by his work in the Pacific Ocean. The mean thickness for the Pacific Ocean is about 6 km., which contrasts with the 30 km. for the continents.

Questioned on the dependence of arrival time on frequency, Dr. Raitt said that only at short distance was it possible to observe waves of different frequency travelling over the same path. In these cases, no dependence on frequency was observed. When asked by the chairman if he had any views on the composition of the layer below the unconsolidated sediments, Dr. Raitt said that it is in doubt whether they are volcanic or sedimentary. The answer to this problem would tell us much about the history of the oceans. If the 4·0–6·0 km./sec. layer is lithified sediment, the oceans are probably very much older than would be expected if the layer were igneous.

Dr. S. Wyrobek (British Petroleum Co.), who read the third paper, said the refraction method has been used in some areas to give a fairly comprehensive picture of the variation of velocity in both the lateral and vertical directions and to reveal sub-surface structural features. It is known that the method is most successful where velocity contrasts are pronounced, but it has been perfected to the extent of delineating layers where the velocity contrast is less than 2,000 ft./sec.

The guiding principle in deciding the disposition of geophones and shots is to cover continuously all the important refractors in the area and especially the shallow refractors, since these greatly influence the shape of the deeper layers. A refraction line consists of several spreads. Each spread may have twenty-four geophones 250–1,000 ft. apart and several main shot points outside the spread at distances of 5,000–10,000 ft. At each geophone station or every alternate one, smaller shots are fired, which elucidate the weathered layer and any low-velocity layers. Continuous time profiles are obtained in both directions of shooting, and these are used for obtaining half-intercept time values and hence the values of the refracting velocities and their lateral variations. By the method of interpretation used, individual refractors are discriminated by ensuring that the reciprocal times are equal, that the intercept times match in each direction of shooting, and that both the direct and reverse time profiles match the half-intercept time values if one deals with the same refractor.

The aim of the method is first to convert the time–distance curve into a time section, that is, into a section in which the vertical scale gives the delay-time of a point on the refractor below the datum; this is achieved by producing the so-called half-intercept time profiles. From the latter, by using information obtained from well surveys or assuming the seismic velocities determined for the upper refractors to be uniform in a vertical direction, or introducing a velocity distribution characteristic of the area, a depth profile for each refractor is easily obtained.

Mr. D. R. Brown asked what velocity variations and dips could be encountered before the method broke down, to which Dr. Wyrobek replied that the complications would appear where lateral variation of velocity along a refractor approached the variation in the vertical direction. The method has proved satisfactory in areas of dips up to 8°. It will be published in a subsequent number of the *Geophysical Prospecting Journal of the European Association of Exploration Geophysicists.*

[1] Peterson, R. A., Fillippone, W. R., and Coker, F. B., *Geophysics*, 20, No. 3, 516 (1955).

ELECTRICAL EQUIPMENT OF AIRCRAFT

THE convention, as a means of bringing to a focus widely scattered knowledge of a particular subject, has gained a great deal of popularity in recent years, and that on "Electrical Equipment of Aircraft", held in London at the Institution of Electrical Engineers during May 2–4, proved to be no exception; the accommodation of the lecture hall of the Institution was strained to the utmost, and additional chairs were placed wherever possible. The chair at the opening session was taken by the president of the Institution, Sir George H. Nelson, and the proceedings began with a short address by the Minister of Supply, Mr. R. Maudling.

Mr. G. R. Edwards, general manager and chief engineer (aircraft) of Vickers-Armstrongs, Ltd., followed with a most entertaining talk, in which his humorous sallies provided some light relief for the serious matter of his address, which was the problem of the aircraft designer, wishing and indeed compelled to use electricity to an ever-increasing extent for a multitude of purposes in connexion with the functioning of the aircraft, and yet faced with the reduction of useful load-carrying ability involved in the weight and drag of electrical equipment and its cooling auxiliaries. The only electrical equipment on the earliest aircraft was a magneto generator to supply the ignition system, and this was both light and reliable. Modern large civil and military aircraft are equipped with about 150 kW. of electrical power and, with developments likely in the near future, the power provided may rise to 400 kW., or even, according to some estimates, to 700 kW. The weight of the equipment, with the additional fuel required to drive it, is of the order of 3 per cent of the total aircraft weight. If the pay-load of a civil aircraft is 10 per cent of the total aircraft weight, the electrical equipment reduces the pay-load by one-quarter, and the importance of saving weight is apparent.

Important as it is to save weight, it is still more important to achieve reliability. Moreover, the increase in speed and flying height of modern aircraft introduces new problems of cooling and brush-wear which are generally adverse to saving weight. The designer is at a disadvantage compared to his land-based colleagues in every respect except cost, which he may largely ignore if a saving in weight may be achieved by the use of costly materials or special apparatus.

Nineteen papers* were presented at the convention covering the uses of electrical power, the means to obtain it and the methods and equipment necessary to obtain reliability. The last session was devoted to a discussion of the problems of installation and maintenance, which often influence the choice of equipment for a particular aircraft.

The importance of weight-saving would appear to justify the design of the electrical equipment as a single unit, each element being planned to give minimum total weight to the equipment rather than to have minimum weight itself. This ideal has not yet been achieved, and the choice of supply system, for example, is often governed more by the availability of consuming apparatus of a given design than by a rigid assessment of the optimum system for minimum weight.

The most popular generating systems at present are 28 volts and 112 volts d.c., and 200 volts three-phase a.c. with 115 volts between line and neutral. The frequency of a.c. supplies may be variable from 200 c./s. to 500 c./s. according to engine speed; or generation may be achieved at a fixed frequency of 400 c./s., 1,600 c./s. or 2,400 c./s. either by a differential speed drive between the engine and the generator or by a separate power unit. It is unfortunately not practicable to design all consuming apparatus to operate from the same supply system; and, whichever system is adopted, means have to be provided, usually by additional motor generator sets, to provide auxiliary supplies.

The 28-volt d.c. system is popular on account of ease of maintenance and reliability. Fewer cells are required in a standby battery, and heater filaments for this voltage are of adequate section so that they fail less frequently. Transmission losses and the weight of cable required become serious in large aircraft, although this aspect is complicated by the large number of cables the dimensions of which are fixed by considerations of mechanical strength rather than by current-carrying capacity. Aluminium conductors offer the possibility of reduced weight for the same current-carrying capacity, but at the expense of increased volume. It is not always practicable to accommodate the larger aluminium cable.

The 112-volt d.c. system generally yields a reduction of weight both of the generators and of the cables, although the reduction of weight is not as striking as might be expected, since the additional insulation increases the weight of cables of minimum section.

The a.c. systems gain flexibility from the use of transformers; but the transformer weight is not economically used in the variable-frequency system. Moreover, some constant-frequency supplies are necessary for some of the consuming apparatus, and this has to be provided by motor generators. These additions of weight have to be balanced against the reduction achieved by a direct engine drive. The constant-speed hydro-mechanical drive or the auxiliary power unit to give constant frequency is gaining in popularity.

A serious problem for high-altitude flying is brush wear. This problem is less serious with slip-rings than with commutators, so that a.c. supplies have an advantage in this case. The development of satisfactory silicon rectifiers which can be operated at higher temperatures than germanium rectifiers makes possible the design of brushless alternators and also enables d.c. supplies to be obtained with a reasonable weight penalty from a.c. generators.

The most popular frequency system is 400 c./s. Transformer weights are reduced at the higher frequencies; but this advantage is counterbalanced to some extent by increased eddy-current losses in cables. The higher frequencies may be essential for some consuming apparatus.

The cooling of electrical equipment is a major problem, especially at high altitudes and speeds. Designs of minimum weight of electrical equipment tend to be inefficient, and this increases the weight of cooling equipment and the drag it exerts on the aircraft. In many cases, it is preferable to increase the efficiency of the electrical equipment at the expense of its weight in order to reduce the cooling problem. So far as practicable, engine fuel should be used for absorbing heat: additional cooling is usually air cooling, either by natural convection and radiation, or by blast cooling. Limits are set by ambient air temperature which rises with the speed of the aircraft on account of adiabatic compression at the intakes. When the ambient air temperature is higher than that of the electrical equipment, refrigeration must be employed in order to dissipate the heat.

Striking developments of batteries have taken place in the search for weight reductions. The lead–acid battery has been reduced about 40 per cent in weight by improved materials and construction, while the newly developed nickel–cadmium battery and zinc–silver oxide battery give a better discharge performance than the lead–acid battery.

Finally, the smooth functioning and reliability of the equipment is vitally dependent on satisfactory frequency and voltage regulators and on a good protection system, including adequate switchgear. Switch performance is generally adversely affected at high altitudes by the change in the arc characteristics; although research has shown that this deterioration is not as severe as early experiments had suggested, it is clear that alternating currents are likely to be more easily interrupted than direct currents, and this is a further argument in favour of the a.c. system.

*S. F. Follett: electrical equipment in aircraft—survey of past and present practice and future trends in design. H. Zeffert: factors in the utilization of electrical power in aircraft. B. J. O'Kane: aircraft radio power supplies—a survey. J. F. Lewis and E. Lloyd: the airworthiness and reliability of aircraft electrical systems. A. Ball and R. N. Lake: the medium-voltage d.c. system in aircraft and its application in the "Princess"-class flying boats. P. L. Cronbach: rectified-a.c. generating systems in aircraft. P. C. Finucane: a constant-frequency a.c. system for aircraft. D. C. Flack: future trends in aircraft electrical systems. R. G. Woodall, P. J. Daglish and V. A. Higgs: trends in the development of airborne electrical equipment, with particular reference to constant-frequency a.c. systems. G. Adkins, W. Philipp and A. Hossle: electrical machines for aircraft. C. S. Hudson: the cooling of aircraft electrical equipment. K. J. Payne: electrical characteristics and protection of aircraft power systems. W. G. Bourne and A. Grieve: aircraft switchgear. D. W. Bird, D. C. Hancock and D. B. McKenzie: aircraft electrical cables. C. W. Cooper: the development of voltage and frequency regulators for aircraft electrical systems. G. A. Earwicker: aircraft batteries and their behaviour on constant-potential charge. A. H. M. Arnold and L. H. Ford: d.c. circuit interruption and arc characteristics at low air pressures. I. A. Mossop and F. D. Gill: the current and voltage relationships of a stable d.c. arc between copper and silver electrodes in air at 1–760 mm. of mercury. N. C. Adcock and A. W. Ford: excitation systems for a.c. aircraft generators.

Most aspects of aircraft electrical equipment were thoroughly covered by the papers presented, and these, together with the discussions on them, should provide a useful work of reference for those concerned with the design or utilization of such equipment. An interesting point made was concerned with the adverse effect of standardization on the weight of electrical equipment, and a plea was entered for an increase in the number of standard sizes in order to reduce the weight penalty.

MARINE BIOLOGY

SYMPOSIUM AT THE SCRIPPS INSTITUTION

A SYMPOSIUM on "Perspectives in Marine Biology" was held in the Scripps Institution of Oceanography, La Jolla, California, during March 24–April 2, under the auspices of the International Union of Biological Sciences and jointly sponsored by the University of California and the Office of Naval Research of the United States Navy. Owing to generous financial help and to the co-operation of the Military Air Transport Service of the United States, a large and representative body of marine biologists attended from all parts of the world, eight being from Great Britain. The programme of prepared papers covered the whole range, and indeed more than is usually regarded as the whole range, of the composite science of marine biology. Certain of those invited to participate came to give accounts of work of very wide biological implication, and they also made major contributions to the discussions which followed the papers. Very adequate provision had been made in the time-table for such discussions.

It is undoubtedly true to say that no such broad survey of the field of biological investigation in the marine environment has hitherto been held. Observation and discussion ranged from the factors of the marine environment to the study of bottom fauna and of plankton communities, through problems of biochemistry and regulation, both chemical and in respect of timing and rhythms, to problems of production and productivity, notably in relation to both phytoplankton and bacteria. The importance of ethology was stressed, and both the sensory equipment and effector mechanisms of marine organisms were discussed. Problems of speciation and of genetics formed the subject-matter of the concluding sessions of a programme that had been organized by Prof. A. A. Buzzati-Traverso, to whose distinction as a geneticist must certainly be added high ability as an organizer.

An experiment of great interest was made during the symposium, the participants in which were organized into a series of 'idea groups' of very mixed membership where the subject-matter of the papers and general matters appertaining to marine biology were informally discussed. The concluding session of the symposium took the form of a meeting at which spokesmen of the various groups gave some account of their deliberations and answered certain leading questions which had been put to them. In the opinion of the writer, himself one of the spokesmen, profitable use could probably be made of such a scheme in future, although perhaps in this instance both subject-matter and participants were somewhat too heterogeneous. A doubt was left as to whether those who organized the symposium would obtain any major lead from the deliberations of the idea groups.

But there can be no doubt that, as a result of the discussions, both formal and informal, all who attended the symposium left it with increased knowledge both of their science and of their colleagues from many countries. Regret was widely expressed at the absence of the delegates expected from the U.S.S.R. The Scripps Institution of Oceanography now has the possibilities, through a major grant of money from the Rockefeller Foundation, to develop greatly the biological aspects of its work. Those responsible for the symposium must certainly have gained an idea of the extent and diversity of modern investigations in marine biology. The majority of these, outside the field of fishery research, are the achievements of individual workers, although naturally such work is being increasingly aided by the facilities of modern marine biological laboratories and research vessels. Along what lines of research money might most fruitfully be spent would, at this stage, seem to depend more on the quality of the people employed than on the actual programme, and it is to be hoped that the Scripps Institution will be successful in its endeavours to obtain workers of the highest quality to develop its biological programme.

C. M. Yonge

SCIENTIFIC HUMANISM

IT is a commonplace of discussions on the universities that there is an ever-widening gap between the arts and the science graduates: this usually takes the form of a most often unjust attack on the 'narrow scientist'. S. J. Tester, a lecturer in classics at the University of Bristol, suggests that the 'narrow arts graduate' is a commoner phenomenon and represents a more serious problem (*Univ. Rev.*, 28, No. 2; Feb. 1956).

Most graduates in one of the special sciences will, in a time of films and theatres, radio and television, "Penguins" and "Pelicans", imbibe something of what the arts man so often describes as 'culture'; but most arts graduates leave the universities with practically no conception of the revolution that took place in science between the seventeenth and nineteenth centuries, and the further revolutionary developments which have occurred since 1900. Unfortunately, they leave not feeling ashamed of this ignorance but either proud of it or indifferent to it; they consider it irrelevant to their being 'cultured' or 'educated'. Tester suggests a way in which both these problems—that of the science graduates' lack of contact with the minds of the great thinkers of the past and that of the arts graduates' blindness on the side of science—might be at least partly solved.

The way in which the universe in all its physical aspects is now regarded is largely due to developments in science between the seventeenth and nineteenth centuries; it is to be expected that new developments in physics, physiology, psychology and electronics will produce changes in men's commonplace opinions in the future. It is possible to draw up a list of half a dozen or so books which would epitomize the 'scientific revolution', all, or nearly all, books written for the educated public of their day by men of generally acknowledged genius or importance, and all readable by any intelligent student.

A suggested list is: Harvey's "De Motu Cordis" (1628); Galileo's "Dialogue concerning the Two Chief World Systems" (1632), selections; Boyle's "Sceptical Chymist" (1661); Newton's "Principia" (1687), selections, but at least the early chapters of Books 1 and 3; John Ray's "The Wisdom of God" (1691); James Hutton's "A Theory of the Earth" (1785), or possibly selected parts of Lyell's "Principles of Geology"; Darwin's "Origin of Species" (1859); Einstein's "The Theory of Relativity" (1926). All university students, whatever their faculty, should be required to read these books and to take an examination on them at the end of the first term of their final year,

Such a course of reading would not be intended to make science students philosophical, nor to introduce them to the philosophy of science. It would give them real contact with greatness, such as the classic student has in reading Aeschylus or the philosophy student in reading Kant.

There is no question here of 'broadening' the scientist, of providing a humanist background for his studies. Nor is this proposal intended to provide the arts student with an outline of modern science or a 'potted' history of science. The way in which the scientist, and even the ordinary non-scientist, regards the physical universe has been largely determined by these works or the movements they epitomize; to think as we do and yet be ignorant of them is like being ignorant of the teachings of the New Testament while living in a Christian society.

Most of these are very old books, and much of their matter is long out of date. It would therefore be necessary to explain to what degree the facts and theories given in these works are still accepted, and how far they have been modified or discarded. It would also be necessary to make it plain to the students precisely why these works are important. This would mean putting each in its context, describing the state of each particular science before the work in question, the revolution affected by it, and its influence and importance in later scientific thought. This could be done in a course of lectures; but Tester believes this could be better done in a book prepared by experts in the several fields.

ECOLOGICAL ANALYSIS OF THE INTERBREEDING OF CRESTED TITMICE IN TEXAS

ECOLOGY and behaviour during the early phases of the nesting cycles have been compared by Keith L. Dixon in two superficially distinct forms of titmice. A grey-crested bird, the tufted titmouse (*Parus bicolor*), is a characteristic inhabitant of deciduous forests of the humid eastern United States. Its distributional-range meets that of the black-crested titmouse (*Parus atricristatus*) at a few points in central Texas. The latter bird is found commonly in openly spaced plant associations of arid north-eastern Mexico and adjacent parts of Texas. Interbreeding occurs wherever populations of these non-migratory forms are in contact.

Field work in central and western Texas was carried out during February–April 1951 and in January and February 1952. Each of the forms was studied first in areas remote from any influence of the other form; this study was used as a basis for evaluating conditions in areas where interbreeding was known to occur (University of California Publications in Zoology, 54, No. 3).

Tufted and black-crested titmice are similar in their habitat relations, especially in nesting requirements and foraging. The preferred habitats of these birds merge at the points of contact which lie in a transition from humid to arid climates. The call notes of the western form seemed louder and more nasal, and the songs were of longer duration. The only difference in display was the more erect carriage of the crest in the black-crested form. As the nesting cycle advanced, tufted titmice tended to be more secretive, whereas black-crested pairs were not so difficult to locate. Defence of territory appears more vigorous in the tufted titmouse. These differences in behaviour are more apparent later in the breeding cycle than they are at the time when pair formation is believed to occur. Detailed studies in the field, correlated with examination of specimens, suggests that mate selection is random where the populations overlap. No evidence of reduction in the vitality of birds of intermediate character was found. The evidence suggests that these two varieties diverged from a common ancestor, but that the changes which developed were not accompanied by the evolution of mechanisms which would ensure reproductive isolation. Since free interbreeding between black-crested and tufted titmice occurs, Dixon suggests that they should be considered conspecific.

The three principal areas where contacts between populations of the two kinds of titmice exist or have existed were studied. In each area the junction was permitted by extension of woodland vegetation across prairies otherwise uninhabitable by these titmice. The upland timber of these areas is controlled by factors operating through the soil. This fact points to the permanence of the distributional relations, and the suggestion is made that the interbreeding of these titmice antedates the environmental disturbances brought about by the settlement of Texas by the white man.

The genetic constitution of one intermediate population, near the Aransas River, is shown to have changed towards that of the black-crested during the past century. The spread of woody vegetation is believed to have favoured the increase in numbers of titmice of the black-crested type in this area, and hence to have permitted increases in frequency of its genes in the intermediate population, while the contribution from the grey-crested populations was being reduced.

STANFORD RESEARCH INSTITUTE, CALIFORNIA

REPORT FOR 1955

THE report of operations for 1955 of the Stanford Research Institute, California*, records an increase in staff from 914 to 1,163, of whom 630 have technical training and 125 Ph.D. degrees. Contract research is being conducted at the rate of 10 million dollars a year, and in the nine years of the Institute's

* Stanford Research Institute. Report of Operations, 1955. Pp. 47. (Menlo Park, Calif.: Stanford Research Institute, 1956.)

existence has totalled about 35 million dollars. Of the 532 research projects undertaken in 1955, 132 were for government agencies; but in terms of dollars the ratio of commercial projects to government projects was 56·6 : 43·4. Following a final decision as to the site, rapid progress was made in developing building programmes for offices and research activities. The Associate Plan was further extended, and by the end of the year 116 firms or individuals had pledged or contributed one or more units of 15,000 dollars, totalling 2,266,525 dollars, to this fund for improving the Institute's research facilities.

Progress was made in the solar energy programme, including a study by the Institute of flat-plate collectors, in which a solar-heat pump from the Somor Company of Italy was used, studies of the feasibility and design of extremely large solar furnaces for high-temperature research, and the production of a directory and bibliography of research in this field. A reflector-type furnace for temperatures in the range 2,000°–3,000° C. has been designed which can be used interchangeably with three sources of radiation-solar, flame and the electric arc. A feature of the activities during the year in this field was the international symposium on applied solar energy, held in Arizona during November 1–5. A new phase of activity in the field of nuclear energy was to assist companies contemplating entering this field by evaluating possible markets and analysing the need for development work and associated manufacturing, marketing and financial problems. A Nuclear Energy Service was established to provide a source of up-to-date information on developments, and a study of the most suitable design of industrial reactor led to the selection of a reactor of the heterogeneous type, moderated by heavy water, with a 10-MW. heat output and a maximum neutron flux density of 2×10^{14} neutrons sq. cm./sec. Its power-level is at least ten times that of most research reactors, and it is proposed that the co-operative reactor laboratory should be owned by a non-profit corporation, subsidiary to the Institute, and that the reactor would also be available for use on a contract basis for applied research. Nuclear engineering studies included radiation studies of food products and of chemical reactions induced by radiation, while the possibilities of radiation as an industrial tool were being explored.

An extensive study was made of the research needs of the forest industries, particularly of the West, and in a new physical sciences laboratory reactions of hydrocarbons and their derivatives were being studied at pressures up to 10,000 lb./sq. in. in a new type of reaction chamber providing complete operating safety at low test. A new wing in the chemical engineering laboratory contains high-temperature electric furnaces, a spray dryer, a high-pressure air system and kindred equipment for the development of high-temperature alloys and other materials. The enlarged laboratory is also being used for trials of new processes on a scale sufficient to provide information for the design of pilot plant. In a classified study of ballistic and physical properties of solid propellants, special equipment has been provided for measuring the rate of burning of propellants in strand form, ignition time, and tensile strength at high rates of strain application. The television and vacuum-tube laboratory has been approximately doubled in capacity and has been concerned with research on video recording, the more efficient utilization of television channels and industrial applications of television techniques. From a study of existing air-modulated loudspeakers and of the principles and factors affecting efficiency, the Institute has been able to design a prototype loudspeaker—the Stanford airstream modulator—costing about a fifth as much to build as other units of this type, with about 80 per cent of the theoretical efficiency and which, with only 10 watts of air energy and 10 watts of air control, can be heard about 1·5 miles away. The addition of a new electronic computer greatly increased the ability of the Computation Centre to handle large problems, and in a single afternoon an operations research team obtained data on a complex study of the most economic method of dispatching empty freight cars that normally would have taken one man two years to procure. New equipment has also been installed in the control-systems laboratory for studies of surface physics and materials, and a new laboratory established for research on special problems in the graphic arts. The Poulter laboratories have made contributions to the understanding of detonation and hydrodynamics of shock-pulse phenomena, with consequent severalfold improvement in the efficiency of military and civil explosives, and are also engaged in combustion and general high-pressure research. An irradiation study initiated by the Sequoia Process Corporation led to a new type of polyethylene resistant to 150° C. and suitable for high-temperature application in aircraft and electronics; and, with the Bank of America, the Institute has designed an electronic recording machine which automatically does all checking of customers' accounts.

FUTURE NUMBERS OF UNIVERSITY STUDENTS IN BRITAIN

An address on the number of university students, which Lord Simon of Wythenshawe delivered to the Court of the University of Manchester on November 16, was afterwards published in a revised and extended form in the February issue of the *Universities Quarterly*, and a reprint of this article has been issued entitled "Future Numbers of University Students: the Desperate Need for Technologists"*. In his original address, Lord Simon discussed separately both the national problem and the particular contribution Manchester could be expected to make alike in respect of the general need for expansion and the shortage of technologists; he expressed the view that no expansion should be contemplated at Manchester beyond the five thousand students for which the new buildings would provide, except that, in addition, the College of Technology should expand to reach a student population of fifteen hundred within a decade. In the pamphlet now issued, Lord Simon looks at the question of student numbers purely from a national point of view and, after reviewing the expansion since 1911, considers more particularly the measures which should be taken to meet the situation likely to arise in the next ten years. He assumes that university standards will not be raised, that the universities will continue to accept approximately the present proportion of sixth-form pupils and that accordingly they will expand to the extent necessary to admit

* Future Numbers of University Students: the Desperate Need for Technologists. (Reprinted from *Universities Quarterly*, February 1956.) By Lord Simon of Wythenshawe. Pp. 15. (London: Turnstile Press, Ltd., 1956.) 1s.

the increased number of those attaining present standards which will be forthcoming when the increased population passing through the schools reaches the university stage from 1962 onwards. He estimates that entrants in 1965 are likely on these assumptions to be 40–100 per cent above the present level, and that it is imperative to begin at once to erect the necessary buildings.

Lord Simon lays his main stress on technology. Pointing out that the number of degrees and diplomas in technology awarded by the universities in Great Britain has been decreasing since 1950 (from 3,593 to 3,359), he emphasizes that both the U.S.S.R. and the United States are already producing each year about twice as many graduates in science and technology per thousand of population as Great Britain, and that in the U.S.S.R. the output during the past five years has increased by more than 10 per cent a year. The Federal Institute of Technology at Zurich, he points out, has at present 2,700 full-time degree students, which is more than the three largest technological institutions in Britain put together, and the totals of 3,600 and 3,400 graduate engineers produced in Britain in 1950 and 1954, respectively, compare with 50,000 and 20,000, respectively, in the United States and 28,000 and 54,000 in the U.S.S.R. He urges that the rate of building for universities should be increased at once to provide reasonable accommodation for a 50 per cent increase in the number of students by 1965, and immediate and energetic action should also be taken to increase the output of graduates in technology by 10 per cent a year, with an ultimate output of at least ten thousand engineers a year. As a contribution to this end, he suggests the appointment of a small Royal Commission to report on the situation within six months.

MATING SYSTEMS OF FUNGI

IN a paper under this title, J. H. Burnett (*New Phytol.*, **55**, 1, 50; 1956) has attempted to classify the principal kinds of mating systems, to devise an appropriate terminology for them, and to describe how they operate and are controlled. He points out that, so far, there is no adequate and agreed terminology for describing fungal mating systems.

The terminology now proposed includes the following. Under the term 'heteromixis', he would include those instances, or imply the condition, where sexual reproduction only results from the fusion of genetically different nuclei normally derived from different thalli. Heteromixis includes: (1) 'dimixis', the condition where there are two, and only two, types of complementary nuclei which control mating, the nuclear types being determined by two allelomorphs at a single locus; (2) 'diaphoromixis', the condition where several types of complementary nuclei occur which control mating, the nuclear types being determined by multiple allelomorphs at one or two loci, the bipolar and tetrapolar conditions, respectively; and (3) 'homoheteromixis', this being an essentially heteromictic condition where sexual reproduction results only from the fusion of genetically different nuclei derived normally from the same thallus; such forms are derived from dimictic or diaphoromictic forms, hence the derived terms, 'homo-dimictic' and 'homo-diaphoromictic'.

'Homomixis' is defined as the condition where sexual reproduction can result from the fusion of genetically similar nuclei, these being usually derived from the same thallus. 'Amixis' is defined as the condition where the essential events of sexual reproduction are lacking but where the pre-conjugation and post-meiotic events normally associated with sexual reproduction may occur. The author prefers this term to 'apomixis' since the condition described is one in haploid organisms. It is so defined as to cover a wider range of conditions than does apomixis as used for conditions in higher plants. The author describes how the principal mating systems operate, and concludes that the factors which control compatibility are pleiotropic in their effects. This suggests that mating-type factors are, in fact, groups of closely linked genes.

From a review of the evolution of mating systems, he concludes that it is not possible at present to give a general account of this phenomenon. It is, however, possible to make suggestions concerning the origin and evolutionary processes involved in some of the systems, and some hypotheses are developed. A general conclusion is that mating systems have arisen in a variety of ways and that, in the first instance, selection of potential mating-type factors may not have been for their effects upon compatibility.

RESEARCHES IN THE ARCTIC OCEAN

THE arctic, up to the North Pole, might be an open sea for part of each year if it were not for the piling up of pack ice into thick ridges by storms. Otherwise, ice formed during the intensely cold winter nights would be thawed completely by September. This speculation is advanced by Prof. G. E. MacGinitie, of the California Institute of Technology, in a technical report on arctic life just published by the Smithsonian Institution. Prof. MacGinitie was principal investigator at the Navy's Arctic Research Laboratory at Point Barrow, Alaska. It is highly improbable that the sea surface as a whole ever freezes during the winter to a depth of much over 6 ft. Thousands of lakes and ponds in the country behind the arctic coasts freeze to depths of more than 7 ft., yet this ice melts entirely during the summer.

During the storms of gale force that sweep over the arctic basin, the surface ice is piled up into windrows which may be several times 6 ft. thick. These drift together and constitute the great arctic pack. Summer melting is more than compensated for by the increased thickness of windrowed ice. Ice over offshore areas which has not been piled up by wind and wave disappears completely by September. The movement of the ice pack itself may have some influence on animal distribution. This pack constitutes about 70 per cent of the arctic ice. It is never stable. Previous investigations have shown that it may move as much as 1,000 miles in nine months. There is good evidence, Prof. MacGinitie says, for considering the pack as a great, moving field, the general direction of which is from north-east Siberia to the east of Greenland.

Prof. MacGinitie has also made some observations about Eskimo life.

The Eskimo birth-rate is increased as much as threefold when the arctic people eat "white man's food" instead of their traditional pure animal diet of whale, fish and seal. When hunting was the only means of subsistence, Eskimo women became pregnant only once in several years; but with the new diet they bear a baby about every year.

Of primary importance in the old Eskimo culture is the bowhead whale. Several are taken in the spring of each year and the flesh stored underground in cellars, where it remains edible for three or four years. The whales feed on euphausiids, mysids, pteropods and copepods. Baleen whales probably lead the easiest life of any mammal. These enormous creatures have only to swim slowly through water, which has about the same specific gravity as themselves, opening and closing their mouths and swallowing food. To an Eskimo the most delectable food is whale muktuk, which consists of whale skin with about an inch of underlying blubber. After freezing, the muktuk is cut into small pieces and eaten raw. Next in importance in the native economy is the bearded seal. This marine animal, which reaches a weight of 500–600 lb., feeds almost entirely on amphipods. In winter these seals are hunted in offshore leads. Unlike most seals, they float when shot, so they can be taken easily. In summer they are hunted in boats.

ANAEROBIC DEAMINATION OF D-GLUCOSAMINE BY BACTERIAL AND BRAIN EXTRACTS

By Dr. P. FAULKNER* and Prof. J. H. QUASTEL, F.R.S.

McGill-Montreal General Hospital Research Institute, 3619 University Street, Montreal

THE discovery that D-glucosamine is phosphorylated by adenosine triphosphate in the presence of brain hexokinase[1] and of yeast[2], glucosamine-6-phosphate being produced[2,3], and the demonstration[4] that competition may take place between glucose and D-glucosamine in metabolic events in the cell, led to investigations[5] on the possible inhibitory influence of D-glucosamine on the growth of cells developing at the expense of glucose breakdown. While D-glucosamine proved to be an inhibitor of growth of sarcoma 37[6], and of human epidermoid carcinoma[7], in tissue culture, it is ineffective in suppressing tumour growth in animals and man, though a positive effect was once reported[5]. The failure of D-glucosamine to act as a tumour inhibitor *in vivo* seems to be linked with its relatively rapid breakdown in the body. For this reason, experiments have been carried out to learn the details of D-glucosamine degradation in the cell. This phenomenon has been the subject of investigations by Lutwak-Mann[8], who studied the metabolism of D-glucosamine in presence of animal tissues, yeast and bacteria, and by Rosenberg[9], Rogers[10] and Oka and Murachi[11], who have studied the degradation of D-glucosamine in presence of bacteria. Biosynthesis of D-glucosamine has been demonstrated by Leloir and Cardini[12], who have shown that an interaction of hexose-6-phosphate and glutamine takes place in presence of extracts of *Neurospora crassa* to yield D-glucosamine-6-phosphate and glutamate.

Our experiments have been directed to an investigation of D-glucosamine deamination and have been carried out with extracts of *E. coli* and of brain tissue. The following is a preliminary statement of the results that have been obtained; full details will be published elsewhere. Many of the findings presented here have been reported in a thesis by one of us[13].

About 3·5 gm. wet weight of *E. coli* grown overnight in a yeast extract – peptone medium, and washed with distilled water, using a Sorvall high-speed centrifuge, were crushed in a Hughes bacterial press[14] which had been cooled to −20° C. The frozen crushed material was extracted with 20 ml. water. The debris was removed by high-speed centrifuging in the cold, and the cell-free supernatant was used for the study of D-glucosamine breakdown. Brain tissue extract was prepared by centrifuging in the cold, for 10 min. at 20,000 *g*, a rat-brain homogenate made up in isotonic potassium chloride solution (1 gm. brain tissue to 10 ml. potassium chloride), the supernatant being used as the D-glucosamine deaminating enzyme system.

Incubations were carried out in the conventional Warburg manometric apparatus at 37° under anaerobic conditions, the gas phase being a mixture of 93 per cent nitrogen and 7 per cent carbon dioxide. D-Glucosamine was estimated by a modification of the method of Elson and Morgan[15], ammonia by the method of Braganca *et al.*[16], hexosediphosphate by that of Roe[17] and phosphates by that of Fiske and Subbarow[18]. Sugar phosphates were separated by paper electrophoresis (Durrum[19]), the dried papers being sprayed with the aniline hydrogen phthalate reagent of Partridge[20] to detect the position of the sugars.

Deamination of D-glucosamine and N-acetylglucosamine takes place anaerobically in an extract of *E. coli*, the process being dependent on the presence of adenosine triphosphate and magnesium ions. Little or no breakdown of D-glucosamine takes place in the bacterial extract under anaerobic conditions; in the presence of adenosine triphosphate, however, utilization of glucosamine may be readily demonstrated. For example, 2·8 μmoles of D-glucosamine were removed from the system when 10 μmoles of the amino-sugar were incubated anaerobically with 1 ml. of *E. coli* extract at 37° C. for 45 min. in the presence of 6·7 μmoles adenosine triphosphate. Further results, in which the rates of deamination of D-glucosamine and N-acetylglucosamine are compared, are shown in Table 1. They demonstrate that glucosamine is deaminated at a slower rate than N-acetylglucosamine; but when mixtures of glucosamine and N-acetylglucosamine are incubated with adenosine triphosphate, a more than additive rate of ammonia production takes place.

* Present address: Laboratory of Insect Pathology, Sault Ste. Marie, Ontario, Canada.

Table 1. DEAMINATION OF D-GLUCOSAMINE AND N-ACETYL-D-GLUCOSAMINE IN THE PRESENCE OF *E. coli* EXTRACTS
Present: bicarbonate, 0·028 *M*; magnesium sulphate, 0·0033 *M*; *E. coli* extract, 1 ml. Where added: sodium adenosine triphosphate, 0·0033 *M*. Total vol. 3 ml. Incubation time, 55 min.

	Ammonia formed (μmoles)	Ammonia formed from amino-sugar (μmoles)
Exp. 1		
Adenosine triphosphate	2·2	0
+ D-glucosamine (0·01 *M*)	3·7	1·5
+ N-acetyl-D-glucosamine (0·01 *M*)	4·6	2·4
+ D-glucosamine (0·01 *M*) + N-acetyl-D-glucosamine (0·01 *M*)	7·5	5·3
Exp. 2		
Adenosine triphosphate	0·6	0
+ D-glucosamine (0·01 *M*) + N-acetyl-D-glucosamine (0·0003 *M*)	3·2	2·6
Adenosine-5-phosphate	1·2	0
+ D-glucosamine (0·01 *M*) + N-acetyl-D-glucosamine (0·0003 *M*)	1·5	0·3
Exp. 3		
Adenosine triphosphate		
+ 30 μmoles D-glucosamine	—	0·4
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0·2 μmole)	—	0·9
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0·4 μmole)	—	1·9
+ 30 μmoles D-glucosamine + N-acetyl-D-glucosamine (0·8 μmole)	—	2·9

The virtual necessity of the process of anaerobic deamination of D-glucosamine for adenosine triphosphate makes it likely that the substrate for deamination is D-glucosamine-6-phosphate. A similar conclusion applies to the anaerobic deamination of N-acetylglucosamine, the phosphate ester of which is also formed in the presence of adenosine triphosphate and *E. coli* extract.

Soodak[21] has recently noted that extracts of *E. coli*, prepared by sonic rupture of the cells, phosphorylate D-glucosamine and N-acetylglucosamine in the presence of adenosine triphosphate and magnesium ions.

It is easy to demonstrate by the manometric technique[1] that dialysed *E. coli* extracts bring about the phosphorylation of glucose and D-glucosamine in the presence of adenosine triphosphate, the same hexokinase being apparently involved as shown by competitive experiments. The phosphorylation of N-acetylglucosamine requires a separate kinase as shown by the additive rate of phosphorylation which is exhibited when a mixture of glucose and N-acetylglucosamine is incubated in the presence of an *E. coli* extract and adenosine triphosphate.

Glucosamine breakdown in an *E. coli* extract is inhibited by the presence of glucose. Thus, the addition of 0·01 *M* glucose to a system containing 0·005 *M* D-glucosamine, 0·0005 *M* N-acetylglucosamine, 0·003 *M* adenosine triphosphate, 0·003 *M* magnesium sulphate and *E. coli* extract brought about almost a complete cessation of the disappearance of D-glucosamine. This phenomenon is doubtless due to competition between glucose and D-glucosamine for the same hexokinase. Lutwak-Mann[8] and Oka and Murachi[11] have reported that glucosamine deamination by resting *E. coli* is inhibited by a number of sugars.

Adenosine triphosphate cannot be substituted by adenosine-5-phosphate for the anaerobic deamination of D-glucosamine in an *E. coli* extract (Table 1). A mixture of acetyl phosphate and adenylic acid, however, can effectively replace adenosine triphosphate.

The D-glucosamine anaerobic deaminating system in *E. coli* is unaffected by the presence of either diphosphopyridine nucleotide or by L-glutamate or by pyridoxal phosphate.

Electrophoresis on filter paper of a mixture of D-glucosamine, a trace of N-acetylglucosamine, magnesium ions, adenosine triphosphate, and dialysed *E. coli* extract, after anaerobic deamination at 37° has been allowed to proceed for one hour, shows the presence (after treatment of the paper with aniline hydrogen phthalate) of two products. Their positions are identical with those taken by authentic samples of D-glucosamine-6-phosphate and of hexosediphosphate. Soodak[21] has reported that, in the degradation of N-acetylglucosamine by *E. coli*, fructose-6-phosphate is formed. It is possible that the hexosediphosphate formed in our experiments is produced secondarily by phosphorylation of fructose-6-phosphate by excess adenosine triphosphate present. Thus the evidence would indicate the existence of the following reaction sequence in an *E. coli* extract:

$$\text{D-glucosamine} \xrightarrow{\text{ATP}} \text{D-glucosamine-6-phosphate} \rightarrow$$

$$\text{fructose-6-phosphate} + \text{ammonia} \xrightarrow{\text{ATP}} \text{hexosediphosphate.}$$

Stimulatory effects of N-acetyl glucosamine with E. coli. A noteworthy feature of anaerobic D-glucosamine deamination by *E. coli* extracts is the stimulatory effect of small quantities of N-acetylglucosamine. Although N-acetylglucosamine is itself phosphorylated and deaminated by *E. coli*, its presence in low concentrations greatly increases the rate of D-glucosamine deamination. For example, the presence of 0·0005 *M* N-acetylglucosamine doubled the rate of disappearance of D-glucosamine in an *E. coli* extract containing 0·005 *M* D-glucosamine and 0·003 *M* adenosine triphosphate. Results of a typical experiment showing the stimulatory effect of N-acetylglucosamine on D-glucosamine deamination are given in Table 1.

Crude *E. coli* extracts deaminate D-glucosamine anaerobically so long as adenosine triphosphate and magnesium ions are present. Dialysed *E. coli* extracts bring about little or no anaerobic deamination of D-glucosamine in the presence of adenosine triphosphate and magnesium ions unless a small quantity of N-acetylglucosamine is added.

The stimulatory action of N-acetylglucosamine on D-glucosamine deamination cannot be brought about by such acetylated substances as N-acetylmethionine, acetylcholine or N-acetylglycine.

Inhibition of E. coli phosphatase by N-acetylglucosamine. The stimulatory action of N-acetylglucosamine may be due in part to the remarkable effect of this substance in inhibiting hexosemonophosphate breakdown in *E. coli* extracts. At concentrations of 0·001–0·002 *M*, N-acetylglucosamine will secure inhibitions of 50 per cent or more of hydrolytic breakdown of hexosemonophosphates. Typical results are shown in Table 2. Inhibitions of this order are not found with hexosediphosphate breakdown.

D-Glucosamine at 0·002 *M* shows no inhibition of glucose-1-phosphate hydrolysis with an *E. coli* extract under conditions where N-acetylglucosamine shows 94 per cent inhibition. Neither glucose nor

Table 2. Effects of N-Acetylglucosamine on Phosphatase Activity of Dialysed *E. coli* Extract

Substrate (0·01 *M*)	Concentration of *N*-acetyl-glucosamine	Percentage inhibition of phosphatase
Glucose-1-phosphate	0·001 *M*	50
	0·002 *M*	76
	0·01 *M*	88
Glucose-6-phosphate	0·002 *M*	50
Fructose-6-phosphate	0·002 *M*	33
Hexosediphosphate	0·001 *M*	2

fructose is as effective an inhibitor of glucose-1-phosphate breakdown as N-acetylglucosamine.

In view of this phenomenon, it is suggested that the stimulatory or catalytic action of N-acetylglucosamine on anaerobic D-glucosamine deamination may be due in some measure to an inhibitory effect on the hydrolysis of a phosphate ester formed during the course of D-glucosamine breakdown. Conceivably, however, the phosphate ester of N-acetylglucosamine may play a part in the catalytic reaction.

Deamination of D*-glucosamine by brain extracts.* D-Glucosamine is deaminated anaerobically by a dialysed brain extract in the presence of adenosine triphosphate and magnesium ions. This process is not, however, stimulated by the addition of N-acetylglucosamine. It should be noted in this connexion that N-acetylglucosamine at 0·01 *M* has no inhibitory effect on animal phosphatases, for example, prostate acid phosphatase, intestinal alkaline phosphatase, kidney phosphatase. N-acetylglucosamine is not deaminated in brain extracts, nor does it undergo phosphorylation in the presence of adenosine triphosphate[1]. The presence of glucose inhibits anaerobic deamination of D-glucosamine in a brain extract, this probably being due to competition between glucose and glucosamine or between their respective esters.

The evidence would indicate that D-glucosamine-6-phosphate is the substrate of the anaerobic deaminating enzyme in brain tissue as in *E. coli*, but that the factors in *E. coli*, operating with N-acetylglucosamine and which account for the effects of this substance in the bacterial deaminating system, are not present in the brain extract.

We are indebted to the National Cancer Institute of Canada for a grant-in-aid.

[1] Harpur, R. P., and Quastel, J. H., *Nature*, **164**, 693 (1949).
[2] Brown, D. H., *Biochim. Biophys. Acta*, **7**, 487 (1951).
[3] Sols, A., and Crane, R. K., *J. Biol. Chem.*, **210**, 581 (1954).
[4] Harpur, R. P., and Quastel, J. H., *Nature*, **164**, 779 (1949).
[5] Quastel, J. H., and Cantero, A., *Nature*, **171**, 252 (1953).
[6] Rubin, A., Springer, G. F., and Hogue, M. J., *Cancer Research*, **14**, 456 (1954).
[7] Fjelde, A., Sorkin, E., and Rhodes, J. M., *Exp. Cell. Res.*, **10**, 88 (1956).
[8] Lutwak-Mann, C., *Biochem. J.*, **35**, 610 (1941).
[9] Rosenberg, A. J., *C.R. Acad. Sci. (Paris)*, **226**, 1751 (1948).
[10] Rogers, H. J., *Biochem. J.*, **45**, 87 (1949).
[11] Oka, Y., and Murachi, T., *J. Biochem.* (Japan), **41**, 107 (1954).
[12] Leloir, L. F., and Cardini, C. E., *Biochim. Biophys. Acta*, **12**, 15 (1953).
[13] Faulkner, P., Ph.D. thesis, McGill University (1954).
[14] Hughes, D. E., *Brit. J. Exp. Path.*, **32**, 97 (1951).
[15] Elson, L. A., and Morgan, W. T. J., *Biochem. J.*, **27**, 1824 (1933).
[16] Braganca, B. M., Quastel, J. H., and Schucher, R., *Arch. Biochem. Biophys.*, **41**, 478 (1952).
[17] Roe, J. H., *J. Biol. Chem.*, **107**, 15 (1934).
[18] Fiske, C. H., and Subbarow, Y., *J. Biol. Chem.*, **66**, 375 (1925).
[19] Durrum, L., *J. Amer. Chem. Soc.*, **72**, 2943 (1950).
[20] Partridge, S. M., *Nature*, **164**, 443 (1949).
[21] Soodak, M., *Bact. Proc.*, p. 131 (1955).

FACTORS AFFECTING THE VERNAL PHYTOPLANKTON OUTBURST IN THE ENGLISH CHANNEL

By Dr. W. R. G. ATKINS, C.B.E., O.B.E.(Mil.), F.R.S.
Antony, Cornwall
AND
PAMELA G. JENKINS
Plymouth

WHEN in 1923[1] a systematic survey was begun of the seasonal variation in phosphate in the waters of the English Channel, it soon became clear that the time of the phytoplankton outburst, as indicated by phosphate consumption, might vary by eight or ten weeks[2].

The phosphate is at a maximum about the end of January. Thereafter increasing light intensity favours growth and cell multiplication, though vertical circulation, which brings cells down to badly lighted depths, slows the processes. Warming of the surface water progresses until a stable layer is maintained above a colder deep layer. Since the group of the phytoplankton which predominates in these waters—the diatoms—takes up silica for the valves, the changes in this were also ascertained[3].

The delays in the spring outburst were puzzling and not easily accounted for by any alteration in the seasonal increase in light, though, of course, the influence of vertical mixing is difficult to assess. It was suggested by Harvey[4] that some minor constituent of sea water might be lacking for growth. Sverdrup, Johnson and Fleming[5] also suggested that some conditioning of the water was necessary. It was then pointed out by Atkins[6] that this seemed unlikely as it was so early in the year, and complete regeneration of phosphate, and presumably of other constituents, had just occurred. Furthermore, a lag in phosphate consumption, well beyond that expected from the illumination, was a mathematical necessity. Only after repeated cell divisions could the phosphate consumption come within the limit detectable by our most sensitive methods. Once detectable, repeated doublings in consumption soon led to exhaustion.

There were, however, other questions behind this: How great had the winter reduction in the number of the diatoms been? Multiplication of a smaller stock required, of necessity, a longer period to become perceptible. There might be an inflow of a water mass with a lower population; but against this was a uniform phosphate content and a uniform salinity over an area in which meteorological conditions were reasonably constant. We finally approached the

problem through the neglected study of the algal cells themselves[7]. Filtering water on collodion disks, we extracted with 80 per cent aqueous acetone and examined the clear liquid by spectrophotometer, measuring in the chlorophyll absorption bands. Volumes of the water were also placed in diffuse light, after enrichment with nutrient salts, and the development of many algal species was studied by repeated examination. In time we came across a year in which the low chlorophyll yield found in January was followed by a slightly lower yield in February. Even March was low. At first it seemed impossible. But phosphate determinations in 1925[3] had indicated very similar late development. The routine phosphate and silicate determinations were at this period made by Armstrong[8] and, as always, the salinity by the Government Chemist's Laboratory. Neither temperature nor salinity suggested that the water mass at our station, *E*1, was in February or March different from what it had been in January. Both pointed to identity, as did also the phosphate, which even rose very slightly in February. But the silicate analyses were startling; from February on they were at a much lower level, having fallen from 4·70 to 2·83 μgm. atoms of silicon per litre. This, unaccompanied by a fall in phosphate, was clear proof that we had to deal with a different water mass, in which the chlorophyll values indicated a sparse plankton. The cultures, too, showed certain differences in the predominant species.

It thus appears that the lateness of the phytoplankton outburst was, in 1954 at least, due to a change in the water mass, which was undetectable by the usual criterion, salinity. This does not, however, demonstrate that mere changes in the vertical circulation may not, in other years, be of importance. We hope shortly to publish elsewhere the full account of such yearly changes.

[1] Atkins, W. R. G., *J. Mar. Biol. Assoc.*, **13**, 119 (1923).
[2] Atkins, W. R. G., *J. Mar. Biol. Assoc.*, **14**, 447 (1926).
[3] Atkins, W. R. G., *J. Mar. Biol. Assoc.*, **13**, 159 (1923).
[4] Harvey, H. W., "Recent Advances in the Chemistry and Biology of Sea Water" (Cambridge, 1945).
[5] Sverdrup, H. U., Johnson, M. W., and Fleming, R. H., "The Oceans" (New York, 1942).
[6] Atkins, W. R. G., *Nature*, **156**, 599 (1945).
[7] Atkins, W. R. G., and Jenkins, Pamela, G., *J. Mar. Biol. Assoc.*, **31**, 495 (1953). Jenkins, P. G., "Pap. Mar. Biol. and Oceanogr., Deep-Sea Research", Supp. **3**, 58.
[8] Armstrong, F. A. J., *J. Mar. Biol. Assoc.*, **31**, 495 (1955).

ELECTROMAGNETIC PHENOMENA OF NATURAL ORIGIN IN THE 1·0-150 C./S. BAND

By Dr. PHILIP A. GOLDBERG

Department of Physics, University of Oregon, Eugene, Oregon

ALTHOUGH electromagnetic activity of natural origin has been intensively studied in geomagnetic work, the frequencies involved usually have been no higher than 0·1 c./s. However, Willis[1] has reported the detection of magnetic noise fluctuation signals in the 5–800 c./s. band; and Aarons and Henissart[2] have reported observing signals with equipment of band-pass of 0·5–20 c./s.

To determine some of the characteristics of natural activity at low audio and sub-audio frequencies, the University of Oregon, with the assistance of the Research Corporation, has conducted a series of observations of geo-electromagnetic activity in the 1·0–150 c./s. band. The observations were carried out during the summer of 1955 at an isolated place in eastern Oregon (lat. 43° 27′ N., long. 120° 35′ W.) where no interference by power lines was observable.

For detecting signals, two air-core detector coils were used. One, of effective area 12,800 sq. m., was arranged to observe the vertical magnetic field component; the other, with an effective area of 5,500 sq. m., was arranged to observe the horizontal north–south component. The signals from the coils were amplified with an amplifier having a band-pass of 1·0–150 c./s. Coil voltage wave-forms, proportional to the time-rate of change of the magnetic field, were studied by mean of a photographically recording cathode-ray oscilloscope. Oscilloscope recordings depicting the wave-form of the inducing field itself were obtained with the aid of equalizing networks, adjusted so that the response of an entire observing system, including the detector coil, was proportional only to the instantaneous value of the field. Coil-voltage signal-level was continuously recorded by means of a rectifying, ink-recording milliammeter with linear response.

Activity in the low-frequency bands was found to be due to disturbances which are almost all of a predominantly burst-like form. Fig. 1, a photograph of an oscilloscope display of the wave-form of the

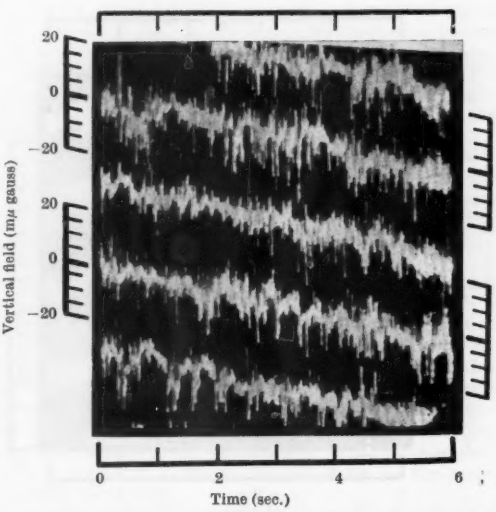


Fig. 1. Oscilloscope display of the vertical component of super low-frequency magnetic fluctuations, 16 : 34, Aug. 18, 1955, L.M.T. In the five-sweep raster, each sweep represents a time of 6 sec.

vertical fluctuating magnetic field, shows this principal feature of the activity in the 1–150 c./s. band. The magnitude of the vertical field bursts are of the order of 10^{-8} gauss. The rate of countable bursts is of the order of 20 bursts per second. Expanded scale-sweeps show the bursts to have durations ranging from 4 to 10 m.sec. (It should be noted that, in Fig. 1, long-period fluctuations, of duration greater than about 0·1 sec., are due to system noise, the low frequencies of which are emphasized by the equalizing network. Also, the broadening of the sweep base-line, when the inducing field is apparently quiescent, is due to small unresolved bursts.)

Both the north–south and vertical magnetic components of the activity are, so far as could be determined, similar as regards rate and duration of bursts. The north–south component is, however, much the stronger, having a magnitude of the order of 3×10^{-7} gauss.

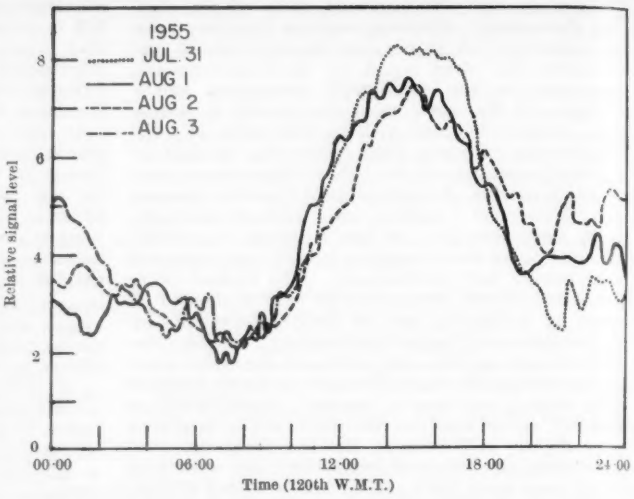


Fig. 3. Daily variation of coil signal-level due to north–south horizontal component of super low-frequency magnetic fluctuations

Coil signal voltage, a typical wave-form of which is shown in Fig. 2, was used as a basis for continuous 24-hr. monitoring of the level of activity of burst disturbances. Coil voltages were amplified without equalization, full-wave rectified and then recorded on a recording milliammeter. The five-second response time of the recorder was sufficiently long to give an easily readable smoothed indication.

The level of the super low-frequency disturbance activity, recorded in this manner, varies considerably during a 24-hr. period, but in a highly systematic fashion. Fig. 3. which is a plot of quarter-hour values of rectified coil-signal voltages, due to north–south field activity, indicates the highly regular and diurnal nature of the variation of the activity.

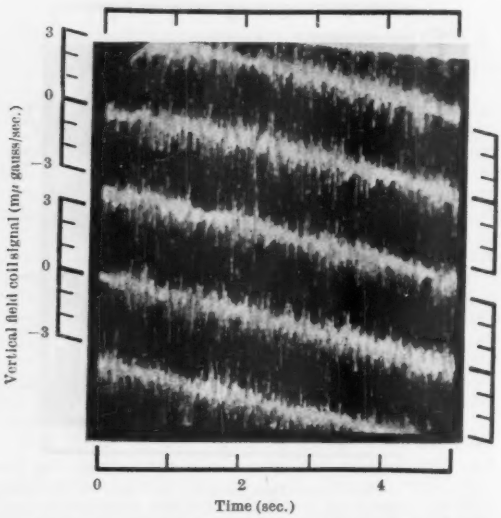


Fig. 2. Oscilloscope display of coil voltage wave-form due to vertical component of fluctuating magnetic field, 16 : 11, Aug. 19, 1955, L.M.T.

The 24-hr. variation of the signal level as observed with the vertical-component coil has a similar form, and for both components the level varies by a factor of about 4 during a typical day.

Analysis of some additional results confirms the regular and pronounced diurnal variation, although there are differences in minor details from day to day. However, the features of a principal minimum occurring at 0700 hr. L.M.T., a secondary minimum at 2100–2200 hr., a very strong major maximum at 1400–1600 hr., and a minor maximum at 2300–0100 hr., were always strongly present during the summer observations.

The burst character of the super low-frequency disturbances is suggestive of atmospherics such as are observed on the radio-frequency bands, and which are attributed to lightning activity. Simultaneous comparison with radio-frequency atmospherics at 500 kc./s. usually showed a correspondence; and so the super low-frequency activity is probably largely, if not entirely, due to lightning activity. However, the daytime maximum of super low-frequency activity as contrasted with the daytime minimum of medium radio-frequency atmospherics signals indicates that different features of propagation are involved.

The general form of the curve of Fig. 3 is taken to represent the manner in which the variation of sources of disturbance is modified by daily variations of the earth–ionosphere propagating system. Because of the extremely long wave-lengths characterizing the super low-frequency activity, it is the variations of the lowest level of the ionosphere which should be important in this connexion. An important feature of the curve in this regard is the regular morning minimum, which for the summer observations occurred at 0700 hr. L.M.T. The indication then is that for the daytime ionosphere the lowest level of ionization affecting super low-frequency propagation between points on the sunlit hemisphere begins to be effective about two hours after ground sunrise.

[1] Willis, A. F., *Nature*, **161**, 887 (1948).
[2] Aarons, J., and Henissart, M., *Nature*, **172**, 682 (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Investigation of Monochromatic Radio Emission of Deuterium from the Galaxy

THE possibility of monochromatic radio emission from galactic deuterium has been well known for some time, and the frequency of such an emission line predicted by Shklovsky[1]. The expected maximum intensity is such that any attempt to detect the line must rely on extremely long integrations in time. In practice, this requires either direct electrical integrations over a long period or the manual summation of a series of individual records. One attempt to detect the line using manual methods has already been published[2].

The radiometer used in our experiments was of a type used by van de Hulst, Muller and Oort[3]. One major difference was the use of a reactance tube switch rather than two oscillators. A filter bandwidth of 16 kc./s. was used, and the spacing between the filters was 48 kc./s. These parameters were derived from considerations based on the hydrogen line profiles in the direction of the galactic centre.

The receiver input stage was a simple crystal converter, which was used mainly for obtaining uniform sensitivity and maximum reliability. The single band noise factor of the receiver was measured at 6, and this noise factor also checked for uniformity over the frequency sweep. A commercial co-axial diode was used for checking the noise factor, and this instrument was in turn checked against laboratory receivers.

Frequency calibration of the second local oscillator (37 Mc./s.) was checked by an interpolation from a 2 and 5 Mc./s. crystal oscillator. These crystal units

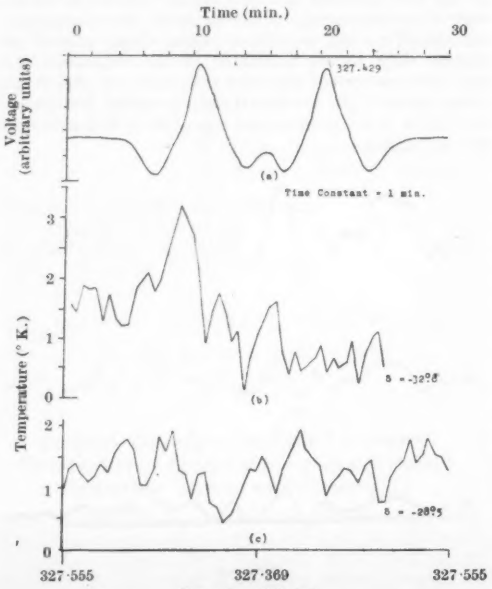


Fig. 1. Integration of five records

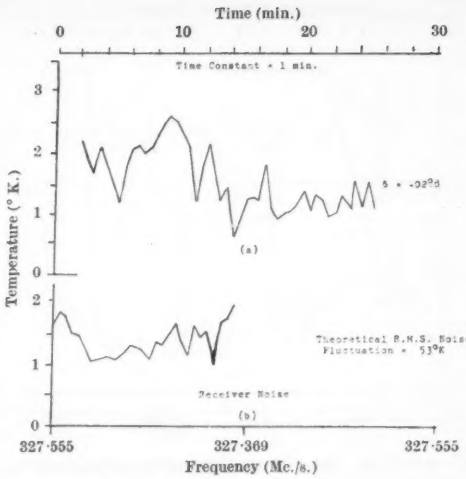


Fig. 2. Integration of eight records

were in turn checked against *WWV*. The drift of this oscillator was found to be less than 1 kc./s. over a period of a month; consequently no check was kept on it during an observation, and calibration was limited to immediately before and after a record. The first local oscillator was set on 296 Mc./s. and a constant check was kept on the heterodyne beat note during an observation with the harmonic of a 2 Mc./s. crystal oscillator.

The antenna system was a paraboloid of 80 ft. diameter, described by McGee, Slee and Stanley[4]. To maintain the frequency response as flat as possible, a cylindrical dipole was used as the primary feed. An overall calibration of the antenna system was difficult due to the limited angular movement of the beam. However, measurements of solar radiation, which were possible only near the summer solstice, were in good agreement with those made on the same day with other solar equipment. A relative check was set up at the same time, consisting of a known signal radiated from a dipole placed near the antenna.

Observations were limited to the region about the galactic centre and the region in the galactic plane at $l - 220°$. All observations were reduced to the local standard of rest.

Early observations were made by automatically scanning with the receiver through 200 kc./s. as the direction of the galaxy passed through the antenna. Such methods failed to detect any radiation. In the later records graphical integration was performed to increase the sensitivity.

A complete frequency scan occupied 15 min., and to compensate partially for the observation with a fixed antenna the phase of the frequency with respect to sidereal time was staggered on successive runs. The time constant of observing was 1 min. Fig. 1(*a*) shows the profile expected from a monochromatic line and Figs. 1(*b*) and (*c*) the results of five integrations at declinations $-32·5°$ and $-28°$. Fig. 2 shows eight integrations at declination $-32·8°$, together with a sample integration of noise alone for the same number of records.

As there was still some doubt about Fig. 2, a further series of four observations with a time-constant of 3·5 min. and a scan of 50 kc./s. was made at declination $-32·8°$, and the results are given in Fig. 3.

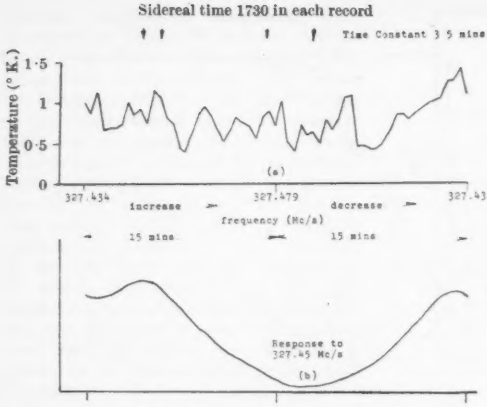


Fig. 3. Integration of four records

We conclude that a monochromatic radiation from deuterium could not be detected at the galactic centre to a limit of better than 1° K. aerial temperature. Shklovsky has estimated that 1/500 of the aerial temperature of the continuous radio radiation from the galaxy at this frequency seen in absorption corresponds to a concentration of deuterium equal to 10^{-3} of the concentration of hydrogen in the galaxy. For the antenna used the aerial temperature of the central source is approximately 800° K. The abundance of deuterium should therefore be less than 10^{-3} that of hydrogen.

This work was carried out during 1954 at the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization, Sydney, Australia.

G. J. Stanley

California Institute of Technology,
Pasadena, California.

R. Price

Massachusetts Institute of Technology,
Cambridge, Mass.

[1] Shklovsky, I. S., *Astrophys. J. U.S.S.R.*, **29**, 144 (1952).
[2] Getmanzev, G. G., Stankevitch, K. S., and Troitsky, V. S., Jodrell Bank Symposium on Radio Astronomy, 1955.
[3] van de Hulst, H. C., Muller, C. A., and Oort, J. H., *Bull. Astro. Neth.*, **12**, 452 (1954).
[4] McGee, R. X., Slee, O. B., and Stanley, G. J., *Aust. J. Phys.*, **8**, 347 (1955).

A Simple Method of studying Winds in the Ionosphere by using Continuous-wave Radio

Systematic study of horizontal movements in the ionosphere has been made during the past few years by using the spaced-transmitter technique developed by Munro[1], which is applicable only for the F_2 region, and the spaced-receiver method first employed by Mitra[2]. However, both these methods require elaborate and expensive ionospheric pulse-sounding equipment. We present here a simple method of studying winds in the ionosphere using continuous-wave transmissions and a simple receiver with a recording system.

The method is essentially similar in principle to the spaced-receiver pulse technique and involves the use of continuous-wave transmissions from a distant short-wave transmitter arriving at the receiving site by way of single reflexion from the ionosphere. Simultaneous records of the variations of signal strength at three spaced points due to these transmissions showed fading patterns which are almost identical but displaced in time. The wind velocities and directions are then estimated from these time displacements using a method of calculation similar to that in the spaced-receiver pulse method.

Continuous-wave transmissions from Madras on the 31-metre band have been used in this investigation for obtaining the simultaneous records of variation of signal strength at the spaced-receiver points. Three simple vertical aerials R_1, R_2 and R_3 each of length 8 ft. are placed at the corners of a right-angled triangle such that R_1 and R_2 and R_1 and R_3 are along the north–south and east–west directions with separations of 64 and 60 metres respectively. The signals induced in all these aerials are brought to a central recording station by using coaxial shielded cable. In the earlier part of this investigation we used three galvanometers which are suitably damped, and three communication receivers connected to these aerials, for obtaining the simultaneous record of the variations of signal strength. Light spots reflected from these three galvanometers trace out the variations of signal strength side by side on the same photographic paper moving with a speed of 12 in. per min. The photographic paper is rolled on a special drum recording-camera driven by a synchronous motor at the rate of one revolution per min. With the view of eliminating the variations, if any, in the signal-strength records for all the aerials, we afterwards simplified the technique still further by using only one communication receiver, National *HR* 07, and a specially designed two-pole three-way rotary switch driven at 1,420 r.p.m. by a 1/8 h.p. motor. The switch consists of two sections each of which has a rotating vane moving over three insulated brass contacts of equal length arranged in a circle. The input and automatic volume control terminals of the receiver are connected to the movable vanes of the two sections of the rotatory switch in such a way that during the rotation each galvanometer is connected to the amplified signal from one of the aerials only during one-third of the rotation. The rate of rotation of the movable vane of the switch being quite high, a smooth fading record is obtained though it is an interrupted signal that is fed to each galvanometer.

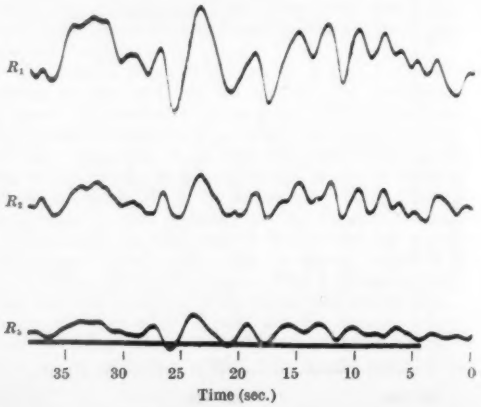


Fig. 1

A typical record obtained with this arrangement on October 30, 1955, from 0900 hr. is shown in Fig. 1. It can be clearly seen that the pattern is almost identical in all the three records with a slight time displacement. From the known data of the critical frequencies and the maximum usable frequency factor it was inferred that the reflexion is from the F_2-region of the ionosphere. The wind velocities and directions in the F_2 region are then determined from these time differences, which are attributed to the horizontal drift of the diffraction pattern on the ground produced by irregularities in the ionosphere. Results obtained for wind velocities in the F_2 layer are found to be in the range 40–90 metre/sec., the direction of wind movement being predominantly in the range of 150°–230° east of north. These observations are in agreement with the values obtained by us using the spaced-receiver pulse technique. We have also tested the reliability of this method by determining the wind velocities and directions from records taken almost simultaneously using the transmissions on the 31-metre band from Calcutta and Madras which are situated to the north and south of Waltair. The values thus obtained for both the records agree very well.

The method has the unique advantage of simplicity of technique, because no pulse transmitter and the associated trigger circuits and oscillographs required for the spaced-receiver pulse method are needed. The only disadvantage is that the transmission must be so chosen that fast magneto-ionic fading and periodic fading due to multiple reflexions are not present. We have chosen the times of observations and the frequencies of transmissions such that only the single-hop reflexion from one layer is prominent.

A detailed report of these investigations will shortly be published elsewhere. We thank the Radio Research Board for sponsoring this research scheme, and the Council of Scientific and Industrial Research for financial assistance.

B. Ramachandra Rao
D. Satyanarayana Murty

Ionosphere Research Laboratories,
Physics Department,
Andhra University,
Waltair, India.
Nov. 25.

[1] Munro, G. H., *Nature*, **162**, 886 (1948); *Proc. Roy. Soc.*, A, **202**, 208 (1950).
[2] Mitra, S. N., *Proc. Inst. Elec. Eng.*, III, **96**, 441 (1949).

Sudden Decrease in Low-frequency Atmospheric Noise during the Cosmic-Radiation Storm of February 23

At Churchill, Manitoba (lat. 58·8° N., long. 94·2° W.), an unusual event occurred on the 100-kc./s. atmospheric noise recordings on the morning of February 23. Churchill is situated near the region of maximum intensity of the auroral zone.

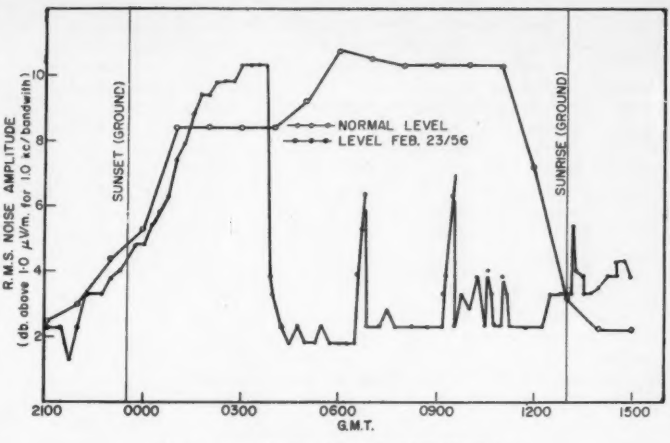


Fig. 1. Atmospheric noise at Churchill, Manitoba

In Fig. 1 two graphs of the root-mean-square atmospheric noise amplitude (decibel above 1·0 μV./m. for a 1-kc./s. band-width) versus time (G.M.T.) are plotted, from 2100 hr. February 22 to 1500 hr. February 23. One of the curves shows the normal variation of noise at Churchill for this particular time of year. The other curve shows a sudden decrease of atmospherics beginning at 0345 G.M.T. on February 23.

This decrease of atmospherics is the first of its kind to be recorded in Canada at a high-latitude station. The largest part of this decrease is a drop in noise amplitude of 6 db. in less than 10 min. The noise continued to fall another 2 db. in the next half-hour to its normal day-time level. The noise continued at this day-time level except for a few short bursts until the early hours of February 24 when the noise-level increased 3–4 db. The atmospheric noise-level did not return to its full normal condition until February 27.

During this same period, in the sunlit half of the hemisphere, Tokyo reported a large solar flare of 'Importance 3', beginning at 0334 and ending at 0414 G.M.T. The time of maximum intensity of this flare was not recorded. During this same period and coinciding in time with the decrease of noise at Churchill, the National Bureau of Standards, Colorado, reported an exceedingly large increase in cosmic-ray activity beginning at 0345 G.M.T.

During the winter months, the nearest sources of atmospheric noise to Churchill are Central America and the northern part of South America. At the time of this sudden fadeout, propagation from these sources was entirely through the dark half of the hemisphere, which makes this particular record unique and, as such, it cannot be termed a normal S.I.D.

The vertical-incidence sweep-frequency ionospheric recorder at Churchill, operating the range of frequencies 0·6–20 Mc./s., did not show signs of increased absorption until 1 hr. later. At 0445 G.M.T. the minimum frequency of $f0F2$ began to increase until 0530 hr., when a total blackout condition existed. During the next 65 hr. a total of 53 hr. of full blackout was recorded. Farther north at Baker Lake (lat. 64·3° N., long. 96·0° W.), the ionospheric recorder did not show blackout condition until 0600 hr. G.M.T., which is one half-hour later than the commencement of the blackout at Churchill. For the same 65-hr.

period a total of 47 hr. of total blackout was tabulated. The more southerly stations, Winnipeg (lat. 49·9° N., long. 97·4° W.) and Ottawa (lat. 45·4° N., long. 75·9° W.), did not show any immediate effect of the ionospheric storm except for a high degree of absorption at the minimum frequency of *f*0*E* and an unusual amount of sporadic *E* during the daylight period of February 23. The ionospheric tabulations from Kjeller, Norway, which is in approximately the same geomagnetic latitude as Winnipeg, Canada, show that the storm there began near 0500 G.M.T., which is the same time as at Churchill, Canada. However, it was much less severe, with only two hours of total blackout condition at 0700 and 0800 hr. G.M.T.

For this solar flare there appeared to be a sudden increase in the *D*-region absorption on the darkened half of the hemisphere which cannot be attributed to ultra-violet radiation. It also appears that this condition may occur only at high latitudes situated near the auroral zone.

C. A. McKerrow

Defence Research Telecommunications Establishment,
Radio Physics Laboratory,
Defence Research Board,
Ottawa.
March 22.

Termination of Chains in Vinyl Polymerization by Metal Salts

In a recent communication, Bamford, Jenkins and Johnston[1] have stated that ferric chloride dissolved in non-aqueous solvents is reduced by polymer radicals according to the equation:

$$m_j + \text{Fe(III)} \xrightarrow{k_t} P_j + \text{Fe(II)} \qquad (1)$$

and that in certain circumstances the rate of formation of divalent iron can be identified with the rate of initiation of polymerization. Our purpose is to report very briefly some recent results obtained in these laboratories, some of which have already been published[2], which (*a*) indicate that the oxidation and reduction of organic radicals by metallic salts is a general phenomenon which can take place in a variety of media, (*b*) confirm that the rate of the reaction depends on the polymeric radical, (*c*) show that the rate depends on the nature of the metal ion, (*d*) show that in a polymerization system in which the probability of chain transfer is low this reaction can be used for determining the number average degree of polymerization, and (*e*) demonstrate that reaction (1) is useful in studying post-irradiation effects.

As regards (*a*) and (*c*), we have pointed out elsewhere[2] that polyacrylamide radicals dissolved in water will reduce the following ions: $Fe^{3+}_{aq.}$, $Fe^{3+}OH^-$, and Cu^{++}. We have recently measured the velocity constants for some of these reactions, and the values at 25° C. for the first two of these ions are $2{\cdot}2 \times 10^{-3}$ and $1{\cdot}4 \times 10^4$ l.mole^{-1} sec.$^{-1}$ respectively[3]. There is evidence that radicals derived from some simple organic molecules such as alcohols and aldehydes by the attack of hydroxyl radicals will reduce ferric ions, whereas those from acetone or acetic acid oxidize ferrous ions[4], and phenyl radicals appear to be capable of either reaction[5], in aqueous solutions. The study of the X- and γ-ray irradiation of de-aerated dry alcoholic solutions of ferric chloride demonstrates the great ease with which this solute is reduced by organic free radicals in this medium[6].

In discussions of the mechanism of these reactions[7], we have emphasized that the lower the ionization potential of the reducing ion the more likely is the organic radical to be reduced, and have cited in support of this the capacity of chromous ions to reduce polyacrylonitrile radicals in water[8]. The hypovanadous (V^{2+}), vanadous (V^{3+}), molybdenous (Mo^{3+}), titanous (Ti^{3+}), uranous (U^{3+}) and azide ions react in a similar way[9]. It has also been pointed out that the reactivities of organic free radicals towards inorganic ions depend on the oxidation-reduction potentials for the processes $R \rightarrow R^+ + e$ ($E_{(-e)}$), and $R + e \rightarrow R^-$ ($E_{(+e)}$)[10].

Recently, we have been re-investigating the behaviour of various polymer radicals in water and now find that, whereas polyacrylonitrile radicals and polyacrylamide radicals will reduce ferric perchlorate, polymethyl methacrylate radicals react only slowly if at all[11]. The implication is that the oxidation potentials, $E_{(-e)}$, of the radicals from acrylonitrile and acrylamide are less positive (on the European scale), while the potential $E_{(+e)}$ of the radical from methyl methacrylate is more positive, than the potential of the ferrous/ferric system under the conditions obtaining.

When the rate of polymerization is proportional to the monomer concentration and the radiation intensity (with ultra-violet light or ionizing radiation) and is inversely proportional to the weighted sum of the concentrations of the ferric species present, the rates of initiation and termination of the chains are equal to the rate of formation of ferrous species in the latter reaction. This relation may be used in two ways. First, the rate of chain initiation can be evaluated in the manner described by Bamford *et al.*[1] and by us[2,3]. Secondly, when the transfer constants are so negligible that the kinetic chain-length is equal to the number average degree of polymerization ($\overline{DP}$) we may write:

$$\overline{DP} = R_p \Big/ \frac{\mathrm{d\,Fe(II)}}{\mathrm{d}t} \qquad (2)$$

and $\overline{DP}$ may be found directly from the measured rates of polymerization and of ferrous ion formation. This is the state of affairs referred to in (*d*) above, and it obtains when acrylamide is polymerized in aqueous solutions containing ferric salts, the polymerization being initiated with light of wave-length 3130 A., X-rays or γ-rays[2,3]. In these systems there is no detectable transfer to the solvent, the ratio of the monomer-transfer constant to the propagation constant[3] is 10^{-5} and the ferric ion present restricts the value of $\overline{DP}$ to $< 10^4$.

In both the catalysed and the radiation-initiated polymerization of acrylamide and acrylonitrile in aqueous solutions, certain long-lived after-effects are observed, the origin of which does not concern us here[3,11]. In the study of these effects it is important to know the rate of initiation, and this may be found quite simply by measuring the rate of ferrous ion formation in systems containing sufficient ferric salt to ensure that chain termination is exclusively by reaction (1). The values of the rates of initiation so

obtained agree with those calculated from other properties of the after-effect[3].

E. Collinson
F. S. Dainton

School of Chemistry,
The University,
Leeds 2.
June 4.

[1] Bamford, C. H., Jenkins, A. D., and Johnston, R., *Nature*, **177**, 992 (1956).
[2] Collinson, E., Dainton, F. S., and McNaughton, G. S., *J. Chim. Phys.*, **52**, 556 (1955), and unpublished work.
[3] Dainton, F. S., and Tordoff, M. (unpublished work).
[4] Kolthoff, I. M., and Medalia, A. I., *J. Amer. Chem. Soc.*, **71**, 3777 (1949).
[5] Baxendale, J. H., and Magee, J., *Trans. Farad. Soc.*, **51**, 205 (1955).
[6] Collinson, E., Dainton, F. S., and Thomson, C. H. (unpublished work).
[7] Dainton, F. S., *J. Chem. Soc.*, 1533 (1952); Special Publications of Chem. Soc., **1**, 18 (1955).
[8] Dainton, F. S., *Disc. Farad. Soc.*, No. 14, 235 (1953).
[9] Dainton, F. S., and James, D. G. L. (unpublished work).
[10] Mackinnon, D. J., and Waters, W. A., *J. Chem. Soc.*, 323 (1953).
[11] Seaman, P. H., thesis, Leeds (1956).

Change of Hardness in Steel due to Hydrogen

A CHANGE in the hardness value of a steel due to the presence of diffusible hydrogen has been detected and found to be in agreement with that predicted from the change in the work-hardening characteristics of the particular steel. This change in hardness has not previously been observed[1-3].

Maximum embrittlement of a steel containing a given amount of hydrogen has been shown by numerous investigators to be dependent on the rate of strain and the temperature of tensile testing. These factors indicate dependence on diffusion. It follows, therefore, that the rate of loading of the indentor in hardness tests must also be critical. A slow-loading hardness test has been devised and has shown changes of hardness dependent on the hydrogen content of the steel.

Specimens were prepared from a wrought, low-carbon (0·17 per cent) mild steel. Hydrogen was introduced cathodically using a 10 per cent aqueous solution of sulphuric acid containing a trace of arsenious oxide and a current density of 0·2 amp. per sq. in. Hardness tests were carried out at room temperature using a ball indentor of 1-mm. diameter and a load of 10 kgm. An oil dashpot device in the hardness tester was adjusted so that the time taken to form the indentation was 60 sec., the load being applied for a further 15 sec. The hardness tests were carried out at fixed intervals of time after charging, the loss of hydrogen with time having been previously determined for similar conditions. The results of the initial tests made immediately after charging, together with conventional hardness determinations, are as shown in Table 1. A plot of the change of hardness with time and hydrogen content is shown in Fig. 1.

Table 1

Method of test	Diam. of ball indentor	Load (kgm.)	B.H.N. of as-received steel		B.H.N. of hydrogen-charged steel		Difference
			Range	Av.	Range	Av.	
Normal	2 mm.	120	116–118	117	115–119	117	—
Slow loading	1 mm.	10	108–111	110	123–130	127	17

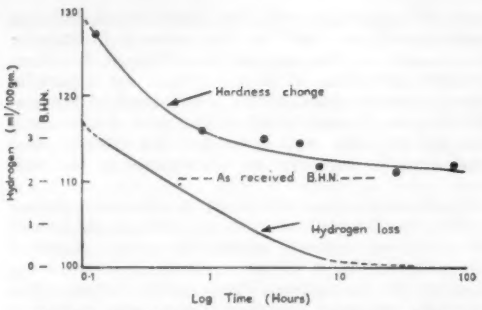


Fig. 1. Decrease in hardness and loss of hydrogen with time

The results show that an increase of 17 B.H.N. was obtained after hydrogen-charging, and that a reversion to the normal hardness values occurred after sufficient time has elapsed for the hydrogen to diffuse from the steel. This change in hardness compares favourably with the increase in slope of the work-hardening part of the stress–strain curve as predicted by Seabrook *et al.*[1] and shown by Vaughan and de Morton[4]. The use of high current densities for cathodic charging produces surface blisters and permanent surface cold-work resulting in a permanent increase in hardness which tends to obscure the above effect.

It would appear from these tests that hydrogen does increase the work-hardening characteristics of mild steel, presumably by the inhibition of slip. A theory relating to embrittlement by the locking of dislocations by hydrogen atmospheres is envisaged and a detailed account will appear elsewhere[4].

It is thought that slow-load hardness testing may be of value in investigating strain ageing phenomena in other systems, provided loading-rate and temperature are adjusted to conform to the rate of diffusion of the solute elements under consideration.

H. G. Vaughan
M. E. de Morton

British Welding Research Association,
London, W.1.
Feb. 14.

[1] Seabrook, J. B., Grant, N. J., and Carney, D., *Trans. Amer. Inst., Min. Met. Eng.*, **188**, 1317 (1950).
[2] de Kazinczy, F., *J. Iron and Steel Inst.*, **177** (1), 85 (1954).
[3] Grant, N. J., and Lumford, J. L., *Iron Age* (June 2, 1955).
[4] Vaughan, H. G., and de Morton, M. E., *Brit. Welding J.* (in the press).

Separation of Hydrocarbon Isomers by Thermal Diffusion

RECENT work on the transport properties of gaseous hydrocarbons[1] has suggested that highly flexible molecules undergo 'wrestling' intermolecular collisions, involving less persistence of forward velocity than collisions between other molecules. Since a straight-chain paraffin molecule is always more flexible than a branched chain, this effect gives rise to differences in the transport phenomena shown by isomeric hydrocarbons. Such differences might be expected to enable separation of a mixture of isomers by thermal diffusion. One view of the mechanism of separation by thermal diffusion is that those molecules which move faster when leaving the hot zone push the slower molecules towards the cold

zone[3]. It is, in any event, clear that thermal diffusion must depend, not only on the mass and diameter of the molecules, but also on the nature of the intermolecular collisions. If a mixture of an *n*-paraffin with a branched-chain isomer is subjected to thermal diffusion, the former, which is the more flexible, will leave the hot zone with lower forward velocity, and would thus be expected to concentrate in the cold zone.

Experiments have been made on thermal diffusion in mixtures of *n*-pentane with *neo*-pentane, and show that a striking degree of separation occurs. Mixtures were admitted to a Clusius column, 1 metre long, consisting of concentric 'Pyrex' glass tubes. The inner tube, of outer diameter 8 mm., was heated to approximately 300° C. by an internal electrical heating element; the outer tube, of inside diameter 16 mm., was cooled by a water jacket at room temperature. The top of the column ended in a 2-litre reservoir; the bottom was connected by capillary tubing to a 20-ml. gas pipette. Samples were taken in the pipette both before running the column and after equilibrium had been attained, and were analysed by mass spectrometer. Equilibrium was reached within four hours. The results are shown in Table 1. The separation factor appears to be sensibly constant over the whole range of concentrations.

Table 1

Total pressure in column (mm. mercury)	Percentage of *n*-pentane: in initial mixture	at bottom of column after separation	Separation factor*
225	43	69	2·04
175	43	64	2·44
175	11	21	2·31
175	91	96	2·37

* ratio: $\frac{\%\ n\text{-pentane at bottom}/\%\ neo\text{-pentane at bottom}}{\%\ n\text{-pentane at top}/\%\ neo\text{-pentane at top}}$

Experiments are being continued with other mixtures of isomeric hydrocarbons, and full details will be published elsewhere.

C. J. Danby
J. D. Lambert
C. M. Mitchell

Physical Chemistry Laboratory,
University of Oxford.
Feb. 7.

[1] Lambert, J. D., Cotton, K. J., Pailthorpe, M. W., Robinson, A. M., Scrivins, J., Vale, W. R. F., and Young, R. M., *Proc. Roy. Soc.*, A. **231**, 280 (1955).
[2] Furry, W. H., *Amer. J. Phys.*, **16**, 63 (1948).

Emission of Photo Radiations by the Impact of Positive Ions of Helium on Nickel

The emission of secondary electrons from metals by positive ions has been studied by a number of workers[1], and it has been established that the efficiency of this process depends upon the work function of the metal, the ionization potential of the ion and their kinetic energy. It is believed that a positive ion becomes neutralized before it actually comes into contact with the metal by extracting an electron from it and is in the excited state when it enters its surface. The energy of excitation of the atom is handed over to another free electron of the metal as it settles down to its ground-state in a radiationless process[2]. This electron escapes from the metal as a secondary emission.

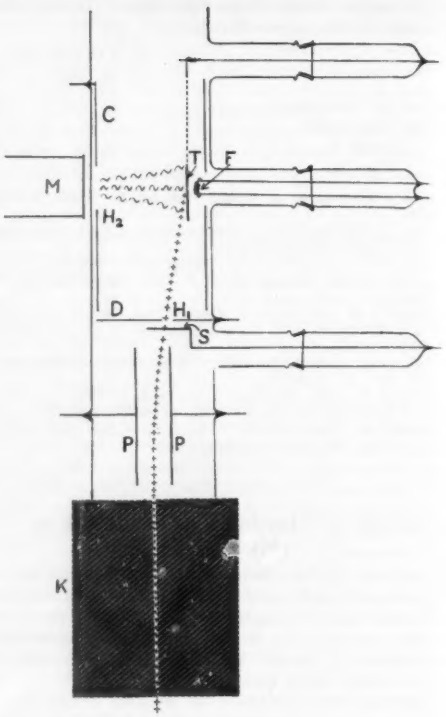


Fig. 1

We have carried out experiments with helium ions to see if their excited atoms formed in the manner described above would undergo transition to the normal state by emitting photo radiations on impact with a nickel surface.

A well-defined beam of ions is obtained from a discharge tube and is allowed to pass between two parallel metal plates *P* in an analysing chamber in which a high vacuum is maintained (Fig. 1). A little beyond these plates is placed a selector disk *D* with an eccentric circular hole H_1. By applying a suitable potential between the plates, the ion beam is deflected to pass through this hole and is made to strike the nickel target *T*, which is suspended from a ground-glass joint in a long nickel cylinder *C* with its lower open end resting just above the disk *D*.

The radiations from the target reach a photoelectron multiplier *M* through a circular hole H_2 made in the cylinder opposite *T*. The flow of ions to the target is stopped, when desired, by an adjustable nickel plate *S* without disturbing the discharge or any other condition of the experiment. The target was made of a degassed nickel sheet supplied by Messrs. Johnson Matthey and Co., Ltd., of London. It was further degassed by the filament *F*.

The pressure in the analyser was kept below 10^{-3} mm. mercury by two fast oil-diffusion pumps working in parallel and backed by a rotary oil pump. Two liquid-air traps, one between the analyser and the pumps and the other between the gas reservoir

and the discharge tube, were used for condensing the impurities and preventing them from reaching the systems.

It has been observed that positive ions of helium give out photo radiations on impact on nickel surface. The energy of the ions used was 200–2,500 volts. That the photo radiations resulted from the impact of ions on the nickel target was verified: (1) by reversing the electrostatic field between the plates P, which deflected the positive ion beam in the reverse direction, and (2) by bringing the nickel plate S in front of the hole H_1 in the selector disk D to cut off the ion beam from the target.

Precautions were taken to ensure that light from the discharge tube or any other part of the apparatus did not affect the photomultiplier.

The apparatus was made of 'Hysil' or 'Pyrex' glass and was washed with helium before observations were taken. The discharge was passed in a cylindrical 'Pyrex' glass tube with a circular nickel disk as anode. The cathode K was made of brass and a hole 1·5 mm. in diameter was drilled along its axis and was water-cooled during the experiments. Spectroscopically pure helium, supplied by the British Oxygen and Acetylene Co., London, was fed into the discharge tube through a fine glass capillary leak from a reservoir maintained at a constant pressure.

Details of the experiments will be published elsewhere. Our thanks are due to Prof. M. L. Oliphant for his interest in these experiments.

Rafi M. Chaudhri
Mustafa Yar Khan
Abdul Latif Taseer

Physics Department,
Government College,
Lahore, Pakistan.
March 13.

[1] Oliphant, M. L., *Proc. Roy. Soc.*, A, **127**, 373 (1930). Moon, P. B., *Proc. Camb. Phil. Soc.*, **27**, 570 (1931). Penning, *Proc. Amst. Acad.*, **33**, 841 (1930). Chaudhri, R. M., *Proc. Camb. Phil. Soc.*, **28**, 349 (1931).

[2] Oliphant, M. L., and Moon, P. B., *Proc. Roy. Soc.*, A, **127**, 388 (1930). Massey, H. S. W., and Burhop, E. H. S., "Electronic and Ionic Impact Phenomena", 541 (Clarendon Press, Oxford, 1952).

Viscosity of Liquids and Ultrasonic Studies

The Debye–Sears diffraction fringes of light, produced by ultrasonic waves from a generator, in the ordinary organic liquids are generally about the same in number. In strong contrast to this, it is found that the number of spectral orders observed in viscous liquids like castor oil, olive oil, etc., are appreciably smaller in number for the same electrical set-up.

To check up experimentally that the electrical condition remained unchanged in these two types of liquids, the oscillator was tuned to a non-resonant frequency of the quartz, midway between the fundamental and the third harmonic, so that vibrations were not set up. The quartz behaved as an additional condenser of the oscillating circuit only. It was noted from measurements that the electric power radiated, and thus, also, the oscillatory electric power of the circuit, remained approximately the same for the different types of liquids. This means that there has been no electrical effect produced by the change of liquids.

On the other hand, according to Raman and Nagendra Nath's theory[1], which has been verified experimentally, the smaller number of spectral orders in some liquids, as compared to others, indicates a smaller change in the refractive index of these liquids produced by the ultrasonic waves. The theory, primarily intended to give the variation of intensity in spectral orders, has been shown by Sanders[2] as well as by Samal and others[3] to give an approximately linear relation between the observed order number and the maximum change of refractive index of the liquids, particularly for order numbers higher than the third.

The experimental results for the set of liquids, on which observations have been made with a particular oscillator generating ultrasonic waves of 3 Mc./sec. frequency, within a distance of 1 cm. from the quartz, are recorded in Table 1. In noting the number of spectral orders, we have observed that in many of the liquids a definite number cannot be set with certainty. It often happens that a lower number appears with certainty and the higher number occasionally sets in. This indicates that the maximum variation of refractive index $\Delta\mu$ has an intermediate value between that required to produce the lower or the higher number of fringes. Under such conditions of observation, we have indicated the number of fringes by the two limits.

It will be observed that the values of $\Delta\mu$ decrease rapidly with the viscosity of the liquid. That the decrease in $\Delta\mu$ in any particular liquid is not caused by the strong absorption in the liquid can be seen by calculating the expected amplitude of change of pressure due to absorption. Since Δp is equal to $V^2.\Delta\rho$ and V, the velocity of sound, is constant in a liquid; also since $\Delta\rho$ is proportional to $\Delta\mu$, any change in amplitude of the pressure will give rise to a corresponding change in $\Delta\mu$ for a liquid. One may thus find that, except in the case of castor oil, where the corrected value of $\Delta\mu$, or n, would increase by one-third of its observed value, the other liquids will suffer negligible change for the experimental distance. The value of $\Delta\mu$ for castor oil, recorded in Table 1, is corrected for absorption.

Table 1. Ultrasonic Spectral Number in Relation to Other Liquid Properties, at 35° C.

Liquid	Density ρ	Velocity in m./sec. (V)	Compressibility	Viscosity (η)	Spectral order $n = \varkappa . \Delta\mu$
Castor oil	0·957	1,460	49·0	3·16	3–4
Paraffin oil	0·876	1,393	58·8	0·765	5–6
Olive oil	0·911	1,398	56·2	0·465	6–7
Coconut oil	0·918	1,365	58·5	0·126	8–9
Turpentine oil	0·871	1,285	69·5	0·012	11–12
Toluene	0·851	1,263	73·6	0·005	13

It will be seen that the results can be incorporated into a fairly smooth relationship between $\Delta\mu$ and η, in the form $\eta = A \exp(-B\Delta\mu)$. No smooth relation occurs between $\Delta\mu$ and compressibility, which might have been the other possibility. The question regarding the decrease of $\Delta\mu$ with increasing η has to be critically considered. The decrease of $\Delta\mu$ could have been caused by the decrease of the amplitude of vibration of the quartz, due to the resisting viscous medium, or it could have been caused by the viscosity effect in the medium, without any change on the vibrating quartz. The effect of viscosity on the propagation of pressure amplitude in the form of absorption has been already considered. No other effect is likely on theoretical grounds. We are thus obliged to accept the view that the decrease of $\Delta\mu$ is due to the damping of the quartz by the viscous liquids.

This would mean that the different media would damp the vibrations of the quartz differently, by a resistance or opposing pressure π, inherent as a characteristic of the liquid. The damping of vibration and π would be larger the larger the viscosity. This also explains the observed fall of power in castor oil, previously recorded in the work of one of us[4]. The observed values of $\Delta\mu$ would thus decrease with the increasing values of π. Thus the relation between $\Delta\mu$ and π for a small range can be represented by $\Delta\mu = a - b\pi$. This would transform the viscosity relation into the form, $\eta = \alpha \exp(\beta\pi)$. It is premature at this stage to make critical observations on α and β, which, within the conditions of experimental limitations, appear to be constants.

It may, however, be noted that Frenkel[5], from considerations of the kinetic theory of liquids, obtained the viscosity relation in the form $\eta = A \exp(\beta p)$, where p is the external pressure and η gives the viscosity of a particular liquid. It appears that the external pressure increases the stiffness of the liquid, measured in terms of π, and so increases the viscosity of the liquid.

A. K. Dutta
B. C. Ray
H. K. Rout

Physics Laboratory,
Ravenshaw College,
Utkal University,
India. Feb. 2.

[1] Raman, C. V., and Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, A, 2 406 (1936).
[2] Sanders, F. H., *Can. J. Res.*, **14**, 158 (1936).
[3] Samal, K., Pattanaik, K. M., and Dutta, A. K., *Ind. J. Phys.* (Nov. 1955).
[4] Dutta, A. K., and Samal, K., *Nature*, **174**, 976 (1954).
[5] Frenkel, J., "Kinetic Theory of Liquids", 191 (Clarendon Press, Oxford, 1946).

Indentation Hardness of Diamond

Recently, S. Tolansky and V. R. Howes[1] published some data on indentation compression strength with a diamond ball (0·39 mm. radius) on differently orientated diamond faces. They obtained values for the pressure which caused cracking on different diamond faces ranging from $1{\cdot}2$ to $1{\cdot}8 \times 10^{11}$ dyne-cm.$^{-2}$ (1,200–1,800 kgm./mm.^{2}). By comparing these values with those quoted in the literature it appears that they are extremely low: F. Auerbach[2], absolute hardness of diamond 2,200 kgm./mm.^{2}; Knoop, hardness[3] of diamond 6,500–8,500 kgm./mm.^{2}; Russian tests with triangular pyramids[4] and my own tests[5] with the same type of indenter indicated hardnesses greater than 14,000 kgm./mm.^{2}. Recent tests with double cone indenters (radius 2 mm., included angle 154°) showed that diamond surfaces could be loaded to well over 3,000 kgm./mm.^{2} without showing any form of cracks even when investigated with the electron microscope (by courtesy of Mr. M. Seal, Cambridge).

It is astonishing that these high average pressures, usually called hardness, should behave so differently with diamond surfaces. An explanation of this phenomenon may be given by the Hertzian formulæ[6] for the maximum pressure $p_{max.}$ between the surfaces.

The values of the average pressure and of the maximum pressure are shown in a histogram (Fig. 1) for a number of tests with various indenters. The average pressures with triangular and elongated pyramids are high, but with spheres and double cones relatively low. However, the relative stress

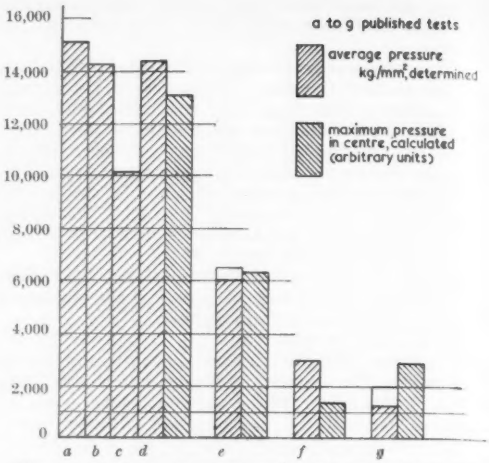


Fig. 1. Histogram of experimental values comparing average with maximum pressures.
a–*c*, M. M. Khrushchov and E. S. Berkovich (triangular pyramid). *d*, P. Grodzinski and W. Stern (triangular pyramid). *e*, Nat. Bur. Standards (Knoop elongated pyramid). *f*, P. Grodzinski (double cone, $r = 2$ mm., $\alpha = 77°$). *g*, V. R. Howes and S. Tolansky (sphere, $r = 0{\cdot}39$ mm.)

factor was based on the highest maximum pressure $p_{max.}$ obtained with triangular pyramids, and made equal to 13,000 kgm./mm.^{2}, which is the average of the average pressures for tests *a*, *b* and *c*. For test *e* we obtain a value of 6,350 kgm./mm.^{2}, which is close to the experimental value. For test *f* the value 1,350 kgm./mm.^{2} is about half the experimental pressure; but here no plastic deformation or any kind of fracture was observed. In contrast to this, in test *g* where elastic deformation was always followed by fracture, the maximum pressure is almost 50 per cent higher than the maximum average value recorded; this obviously indicates that the elastic limit has been well exceeded.

In this way the widely differing values of average pressures in kgm./mm.^{2} of diamond indenters against diamond surfaces can be explained. Obviously, different mechanisms are involved. In the tests with a pointed indenter (triangular and square base pyramids), there is plastic flow at shear stresses, whereas with tests with the double cone and spheres mainly elastic deformations occur up to the moment of fracture, the latter being due to tensile stresses. Therefore the average stress usually designated as hardness has no physical significance without knowing the shape of the indenter and the load. It may also be suggested that this applies to the usual hardness of materials of lower hardness than diamond.

A more detailed account of this work will be published elsewhere. I thank Mrs. A. Hoselitz for carrying out the tests with the double-cone diamond and Prof. S. Tolansky and V. R. Howes for useful comments.

P. Grodzinski
Industrial Diamond Information Bureau,
London, E.C.1.
Feb. 8.

[1] Howes, V. R., and Tolansky, S., *Proc. Roy. Soc.*, A, **230**, 294 (1955).
[2] Auerbach, F., Smithsonian Report, **4**, 207 (1891).
[3] Knoop, *Indust. Diamond Rev.*, **4**, 103 (1944).
[4] Khrushchov, M. M., and Berkovich, E. S., *Zavodskaya Lab.*, (2), 193 (1950); *Indust. Diamond Rev.*, **11**, 42 (1951).
[5] Grodzinski, P., and Stern, W., *Indust. Diamond Rev.*, **11**, 48 (1951).
[6] Hertz, H., "Miscellaneous Papers" (London, 1896).

A New Apparatus for Cathodic Sputtering

THE cathodic sputtering process has been almost completely replaced in recent years by the vacuum evaporation technique for the production of thin solid films. However, renewed interest in the sputtering technique has been created by the discovery that films of metal oxide can be deposited by sputtering from a metal cathode in a glow discharge containing oxygen. Such films are usually required in combination with metal and other dielectric films for interferometry, etc. It is a simple procedure to deposit multi-layer coatings by vacuum evaporation, whereas their preparation is tedious when using the conventional form of sputtering apparatus. This is because it is necessary to break the vacuum and insert a new disk cathode of the required metal for each fresh layer. I have recently developed apparatus for the deposition during one coating cycle, on to plane receivers, of several sputtered films in sequence or for laminating sputtered deposits with vacuum-evaporated films. It is also possible to dispense with the need for rectification of the high-tension output without loss in the sputtering efficiency.

The new sputtering apparatus is shown in Fig. 1 (subject of a patent specification). The glow-discharge electrodes consist of two *V*-shaped elements made of the material to be sputtered and connected to the output of a high-voltage transformer. The leakage current from the supply to earth must be a minimum, otherwise sputtering can occur from earthed metal fittings in the chamber. Each of the *V*-electrodes operates as a cathode electrode on alternate cycles and deposits material on the plane receiver, which is rotated to ensure uniform deposition. The *V*-electrodes are mounted on earthed *V*-shaped shields with a gap of smaller dimension than the depth of the cathode dark space, so that a glow discharge cannot be sustained on the electrode side remote from the receiver surface. A *V*-shaped electrode operated from a d.c. supply has been used in Germany for glow-discharge cleaning prior to vacuum evaporation[1]; but it has not to my knowledge been used in the a.c. form described above for sputtering.

Experiments have shown that *V*-electrodes with arcs subtending an angle from 10° to 180° at the centre of the work plane produce very uniform deposits on a 12-in. diameter receiver when connected to a 3 kV. 500 m.amp. a.c. supply. By shaping the electrodes, it is possible to increase or decrease the thickness of the deposit at the centre of the receiver. The angular gap between electrodes must be such that one electrode does not penetrate the cathode dark space of the other and thereby interfere with the current density distribution over the cathode surface. This can be avoided by mounting the pair of *V*-electrodes diametrically opposite as in Fig. 1. Several such pairs of electrodes can be mounted above a rotary receiver for deposition of films in sequence.

To obtain uniform evaporated films on plane receivers, it is desirable to rotate the receiver and mount the vapour source in an offset position as shown in Fig. 1[2]. Sputtering electrodes can then be arranged with vapour sources for deposition of multi-layers. The vacuum pump used on this latter apparatus must be capable of obtaining low gas pressures for evaporation (0·1 micron mercury) and operate at high pressures (0·1 mm. mercury) with a controlled gas leak into the chamber during sputtering.

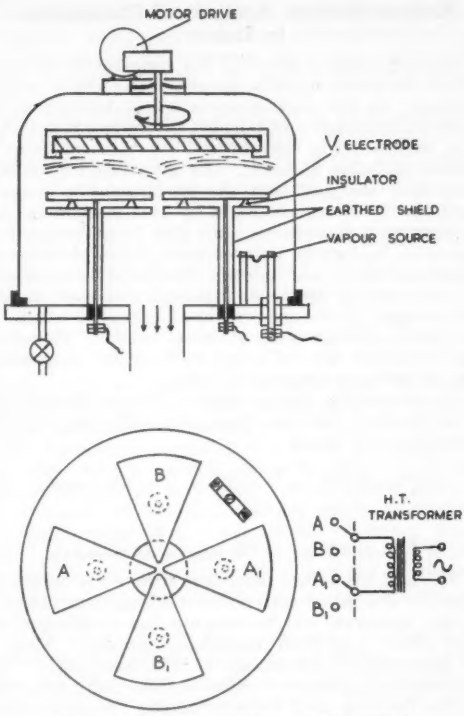


Fig. 1. Sputtering apparatus with *V*-electrodes

Suitable pumps, commonly known as booster-diffusion pumps, are commercially available for this purpose.

The new sputtering apparatus is being used in my laboratory for: (i) preparing durable multi-layer interference filters consisting of sputtered metal oxide films laminated with vacuum-evaporated magnesium fluoride films (titanium oxide films prepared in the laboratory by sputtering in pure oxygen have been found to have a refractive index of about 2·5 and are highly tenacious to glass); (ii) the sputtering of transparent conducting gold films on sputtered bismuth oxide base layers; the properties of this film combination have been described by Gillham and Preston[3] and others[4].

It should also be possible to prepare coatings of alloys and mixtures by sputtering from two *V*-electrodes of dissimilar metals operated from an a.c. supply.

A full account of the new sputtering technique and its uses will be published shortly. Acknowledgments are made to Mr. G. Siddall for his assistance in the construction of a prototype apparatus, and to Mr. A. S. D. Barrett, technical director, for permission to publish this communication.

L. HOLLAND

Research Laboratory,
Edwards High Vacuum, Ltd.,
Crawley, Sussex.
Feb. 9.

[1] Koenig, H., and Helsinger, L., *Festschrift Heraeus Platinschmelze* (Hanau, 1947).
[2] Holland, L., and Steckelmacher, W., *Vacuum*, **2**, 346 (1952).
[3] Gillham, E. J., and Preston, J. S., *Proc. Phys. Soc.*, **65B**, 649 (1952).
[4] Libbey–Owens–Ford Glass Co., Brit. Pat. 682,264. Holland, L., and Siddall, G., *Vacuum*, **3**, 375 (1953).

Radioactivation Analysis of Phosphorus in Iodine

An important method in the preparation of pure silicon for semiconductor devices is the silicon iodide process[1]. In this method silicon tetraiodide is formed from the elements and purified by fractional distillation before being decomposed by passage over a heated tantalum filament. We have found by radioactivation analysis[2] that the predominating N-type impurity in silicon produced by this method in our laboratory is phosphorus, and that its concentration seems to be largely independent of the phosphorus content of the 'crude' silicon. This could be explained if there was an appreciable phosphorus-level in the iodine used, as the mass ratio of silicon to iodine in the above reaction is about one to twenty. Therefore we developed the following method for estimating the phosphorus content of iodine.

On irradiating iodine which contains phosphorus in a thermal neutron flux, the following nuclear reactions take place.

$$^{127}\mathrm{I}\ (n,\gamma)\ ^{128}\mathrm{I} \xrightarrow{\beta^- + \gamma} {}^{128}\mathrm{Xe}\ (t_{1/2} = 25{\cdot}0\ \mathrm{min.}) \quad (1)$$

and

$$^{31}\mathrm{P}\ (n,\gamma)\ ^{32}\mathrm{P} \xrightarrow{\beta^-} {}^{32}\mathrm{S}\ (t_{1/2} = 14{\cdot}3\ \mathrm{days}) \quad (2)$$

The half-life values show that if we allow sufficient time for the iodine activity to die away, the activity in the specimen will be entirely due to phosphorus and other long-lived impurities present. This is of considerable advantage in the handling of the activated samples, as no radiation shielding is required.

The reaction used for determining the phosphorus content is the following:

$$2\mathrm{P} + 5\mathrm{I}_2 + 8\mathrm{H}_2\mathrm{O} = 10\mathrm{HI} + 2\mathrm{H}_3\mathrm{PO}_4 \quad (3)$$

It is of paramount importance that the carrier added to the irradiated sample be in the same chemical form as the active element which is to be determined. This is achieved in the above reaction, as the phosphorus, whether present originally as the element or the iodide, ends up as an orthophosphate ion. The method also has the rather novel feature that the inactive phosphorus takes part in the reaction and, after conversion to phosphate, also acts as a carrier.

The details of the method are as follows. About 0·5 gm. samples of iodine were sealed in silica ampoules and irradiated for a week in the pile at Harwell together with 30 mgm. of diammonium hydrogen phosphate to act as a standard. On return, the ampoules were allowed to stand for a day to let the activity due to the iodine decay and were then cracked open and crushed in a percussion mortar. The mixture was transferred with great care into about 20 ml. of distilled water containing a suspension of 55 mgm. of red phosphorus (a weight in excess of the amount required for the reaction). As the reaction proceeded, iodine was dissolved in the hydriodic acid solution, giving an intense colour. The solution was warmed on a water bath until the iodine coloration had completely disappeared. The residual red phosphorus was then dissolved by adding excess inactive iodine, and standing the solution on the water-bath overnight. The fragments of the silica ampoule were then removed by filtration and the filtrate treated with hydrogen peroxide. Iodine crystals slowly appeared as the iodide complex was broken down and the iodine solubility consequently decreased. These crystals were filtered off. Chloroform was then shaken with the filtrate in a separating funnel to remove final traces of iodine. The procedure was repeated until the final aqueous solution was colourless.

The phosphate was then determined as the magnesium pyrophosphate in the same manner as we have previously reported[2]. Three methods were used for establishing the identity of the activity thus isolated. Absorption and decay measurements were made showing it to be a pure β-radiation with a half-life of fourteen days, and in some cases the solution and precipitation stages were again repeated, the results showing no loss in activity per gram. These facts indicate that, using the above technique, the phosphate isolated is radiochemically pure. The overall efficiency of the method is 70–80 per cent.

If one assumes that the maximum efficiency of the counting system is 25 per cent and that its detection limit is 20 counts per min. above background, then it can be shown that, for irradiation for a week at a pile factor of 10, the limit of the method is about 0·003 part per million on a gram sample.

Phosphorus concentrations, which we have measured in iodine from various sources, have been found to vary between 10 and 0·1 parts per million. A sample of 'Analar' grade iodine was found to contain 0·18 p.p.m. of phosphorus.

We are indebted to colleagues in this laboratory for encouragement and assistance.

J. A. James
D. H. Richards

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby. Dec. 22.

[1] Andersen, H. C., and Belz, L. H., *J. Amer. Chem. Soc.*, **75**, 4828 (1953).
[2] James, J. A., and Richards, D. H., *Nature*, **176**, 1026 (1955).

Crystal Structure of *p*-Chlorbenzene Iododichloride

The unexpected bond distances observed by Archer and van Schalkwyk[1] in benzene iododichloride have indicated a class of organic compounds about which few structural data are at present available. We have therefore sought to confirm their findings by the examination of a related compound, *p*-chlorbenzene iododichloride.

Light-yellow needles of this compound are obtained by passing dry chlorine into a dry chloroform solution of *p*-iodochlorbenzene. Like other iododichloride compounds with an electrophilic group in the *para* position, giving rise to a dipole moment directed away from the iodine atom, *p*-chlorbenzene iododichloride appears to be moderately stable and certainly more so than unsubstituted benzene iododichloride (Table 1). It seems possible that the tendency of electrons to drift away from the iodine atom partially increases the positive charge on the iodine and so makes possible a greater resonance stabilization of the molecule[4].

Single-crystal X-ray oscillation and Weissenberg photographs, taken with copper and molybdenum K_α radiations, indicate a triclinic unit cell: $a = 10{\cdot}1_0$; $b = 4{\cdot}13$; $c = 11{\cdot}0_3 \pm 0{\cdot}04$ A.; $\alpha = 96°\ 42'$; $\beta = 107°\ 27'$; $\gamma = 91°\ 12' \pm 36'$; where b is the needle axis. With the observed density, 2·31 gm./c.c., this corresponds to two molecules per unit cell. The centrosymmetric test[5] was used for deciding between the two alternative space groups. This shows clearly that the ($h0l$) projection must be centrosymmetric,

Table 1

Compound	Melting-point difference, $t_{\frac{1}{2}hr.} - t_{hr.}$ after preparation[a]	Approximate dipole moment[b] of parent iodobenzene
p-$NH_2\varphi ICl_2$	Rapid decomposition*	+ 2·8
p-$CH_3\varphi ICl_2$	2° C.	+ 1·7
φICl_2	2	+ 1·3
p- φ-φICl_2	2	+ 1·2
p- $I\varphi ICl_2$	1	0
p- $Br\varphi ICl_2$	1	− 0·2
p- $Cl\varphi ICl_2$	0	− 0·4
p-$NO_2\varphi ICl_2$	0*	− 2·6

[a] See ref. 2 for all values except the two marked *.
[b] Calculated from values given in ref. 3.

and that therefore the space group must be $P\bar{1}$. The space group has agreed satisfactorily with more detailed considerations of the structure, which place the iodine atom at (0·040, 0·280, $\overline{0·175}$).

The orientation of the molecules is such that there is very little atomic overlapping in the ($h0l$) projection. This projection is at present being refined to give accurate x and z co-ordinates for all the atoms. The y-co-ordinates are being determined from the ($hk0$) projection and from n-layer line data[6].

The main features of the present structure are in agreement with the reported dimensions and symmetrical linearity of the $—ICl_2$ group[1], with the third valency approximately at right-angles to it. Presumably dsp^2 or d^2sp bonds are formed, but not fully used. The plane of the $—ICl_2$ group appears to be more nearly that of the benzene ring than is the case in benzene iododichloride, where they are at right-angles. It is also clear that the main cohesive forces in the crystal are between the iododichloride groups.

Our results are the more interesting because a linear bond configuration around iodine is clearly not possible for the closely related cyclic compounds, such as that formed from *o*-iododichlor-benzoic acid by the elimination of hydrogen chloride[7].

D. A. Bekoe
Ralph Hulme

Chemistry Department,
University College,
Achimota, Gold Coast. Feb. 1.

[1] Archer, E. M., and van Schalkwyk, T. G. D., *Acta Cryst.*, **6**, 88 (1953).
[2] Nichol, J. C., and Sandin, R. B., *J. Amer. Chem. Soc.*, **67**, 1307 (1945).
[3] Appendix to *Trans. Farad. Soc.*, **30** (1934).
[4] Ingold, C. K., and Ingold, E. H., *J. Chem. Soc.*, 1314 (1926).
[5] Howells, E. R., Phillips, D. C., and Rogers, D., *Acta Cryst.*, **3**, 210 (1950).
[6] Cochran, W., and Dyer, H. B., *Acta Cryst.*, **5**, 634 (1952).
[7] Willgerodt, C., *J. Prakt. Chem.*, **49**, 476 (1894).

Ultrasonic Relaxation in Unsaturated Aldehydes

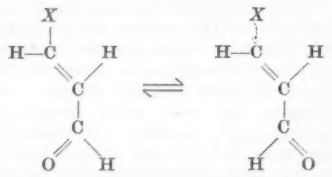
Recent measurements[1] of the absorption of ultrasonic waves in some unsaturated aldehydes over the frequency-range 100 kc./s. to 1 Mc./s. have shown that relaxation occurs in crotonaldehyde and cinnamaldehyde. If α is the absorption coefficient relating to the excess pressure of the sound wave, then in the absence of relaxation the quantity (α/f^2) remains constant with frequency, f. In the region of a single relaxation having a relaxation time, τ, we have[2]:

$$\frac{\alpha}{f^2} = \frac{A}{1 + (f/f_c)^2} + B \qquad (1)$$

provided that the velocity dispersion is negligible. Here $f_c = 1/2\pi\tau$, and the parameters A and B depend upon temperature.

A decrease in the quantity (α/f^2) from its low-frequency value was found for crotonaldehyde and for cinnamaldehyde towards the upper end of the above frequency-range. No such change was found for acrolein.

We attributed the relaxation in crotonaldehyde ($X = CH_3$) and cinnamaldehyde ($X = C_6H_5$)[1] to perturbation by the sound wave of the equilibrium



(2)

These planar configurations are stabilized by resonance, and we suggested that the relaxation in acrolein occurs at frequencies greater than 1 Mc./s.

We have now extended this work by measuring the absorption of sound waves in these liquids at frequencies up to 100 Mc./s. The results confirm the previous explanation and are shown in Fig. 1. The parameters of the relaxations evaluated from the ultrasonic data are given in Table 1, which includes the velocity of sound, c, and the maximum absorption per wave-length due to the relaxation, $\mu_m = \frac{1}{2}Acf_c$.

In order to derive the parameters for acrolein, measurements are required at frequencies greater than 100 Mc./s., and we are in progress of obtaining these with our present apparatus. We are also studying the behaviour in these and related liquids over an extended temperature-range.

It is of interest to note that construction of the scaled molecular model for the ketone, mesityl oxide

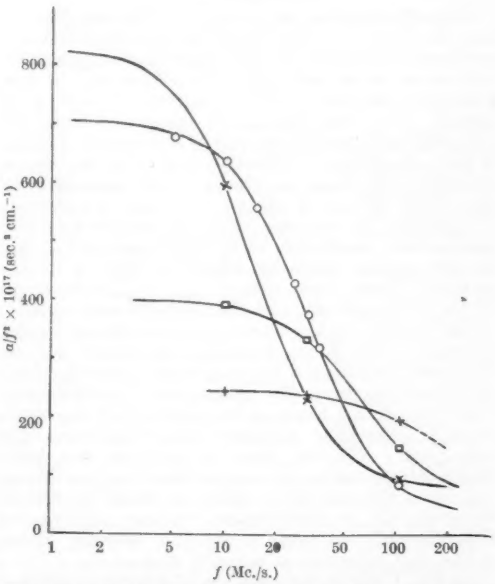


Fig. 1. Sound absorption in acrolein (+ — + —), crotonaldehyde (○—○—) and cinnamaldehyde (×—×—) at 25° C., and in crotonaldehyde (□—□—) at 50° C. The points are experimental, and the curves are calculated from equation (1) using the values of the parameters given in Table 1

Table 1

Liquid	T ° C.	$A \times 10^{17}$ sec.^{2} cm.$^{-1}$	$B \times 10^{17}$ sec.^{2} cm.$^{-1}$	f_c (Mc./s.)	$c \times 10^{-5}$ cm. sec.$^{-1}$	$\mu_m \times 10^{}$
Crotonaldehyde	25 50	674 338	32 60	30·0 61·4	1·268 1·165	1·28 1·21
Cinnamaldehyde	25	746	80	15·1	1·561	0·88

[$(CH_3)_2C : CH\,CO\,CH_3$], shows that the higher-energy state to the right of the corresponding equilibrium (2) is untenable owing to the size of the interacting CH_3 groups. In accordance with this, we have not observed a relaxation in this liquid. Over the frequency-range 100 kc./s. to 1 Mc./s. we found previously that $(\alpha/f^2) = 35 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ at 25° C. The value $(\alpha/f^2) = 36 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ at 100 Mc./s. has been obtained in this laboratory by Mr. E. H. Heasell, to whom our thanks are due.

We acknowledge financial assistance from the Department of Scientific and Industrial Research in support of this research programme. We also appreciate the interest shown in this work by the Koninklijke/Shell-Laboratorium, Amsterdam, by which one of us (M. S. G.) is employed.

M. S. de Groot
John Lamb

Electrical Engineering Department,
Imperial College of Science and Technology,
London, S.W.7.
Feb. 20.

[1] De Groot, M. S., and Lamb, J., *Trans. Farad. Soc.*, **51**, 1676 (1955).
[2] Lamb, J., and Pinkerton, J. M. M., *Proc. Roy. Soc.*, A, **199**, 114 (1949).

Coupled Oxidation of Keto-Acids with Glutathione

When glutathione is oxidized by copper ions or the cytochrome *c* – cytochrome-oxidase system in the presence of pyruvate, the added pyruvate is partially oxidized to acetic acid and carbon dioxide[1]. It was suggested that this reaction occurred by the production of a hemimercaptol compound between pyruvate and glutathione which is oxidized instead of free glutathione. Slater[2], disproving the hemimercaptol hypothesis, emphasized a model similar to that found by one of us[3] for the coupled oxidation of pyruvate by ascorbic acid, which involves the intermediate production of hydrogen peroxide. But the two points made by Slater in support of his postulate have been found to be inconsistent: (1) the chromatic effect of the methylglyoxal – glutathione complex in the ultra-violet, not shown by the pyruvate – glutathione complex, is mainly due to the enediol compound in equilibrium with the thioester resulting from the interaction[4]; enediols and thioesters are not likely to be produced by the interaction of glutathione with pyruvate, which forms only mercaptols; (2) the effect of catalase has been thoroughly investigated and we have been unable to reproduce the inhibitory effect reported by Slater. Moreover, (3) we now present evidence that in our experimental conditions a complex between glutathione and pyruvate is actually formed.

As Fig. 1 shows, the presence of 0·2 mgm. catalase does not appreciably affect the coupled oxidation of pyruvate. Similar results are obtainable by changing the concentration of the reactants or increasing the amount of catalase up to 0·5 and 1 mgm.

In order to test whether, in our conditions of dilution and *p*H, pyruvic acid is really bound to glutathione, we have taken advantage of Schubert's finding that in slightly alkaline solution the nitroprusside reaction of an *R*—SH complex with carbonyls is depressed[5]. Fig. 2 shows that this is the case also with glutathione and pyruvate, and curve 3 represents the curve obtained with the amounts of reactants used in the present experiments. Nitroprusside was added 10 min. after mixing the glutathione solution with the other reactants. The photometric readings were taken in a Coleman spectrophotometer using square cuvettes with prisms leaving a layer of 0·1 cm. cell-length. The unstable coloured reaction was followed under controlled conditions of time.

The coupled oxidation of pyruvate with glutathione occurs also with other keto-acids, though there are some peculiar differences (Table 1). In any event, when the coupled oxidation occurs, it is not appreciably modified by the presence of catalase.

Though the inactivity of catalase seems unquestionable, nevertheless this finding should not be taken as a conclusive indication that the coupled oxidation goes through the hemimercaptol complex; indeed, the peroxidative activity of catalase is well known[6]. The hemimercaptol hypothesis may still hold as a tentative explanation, being supported by the following considerations: (1) the activity of the cytochrome *c* – cytochrome-oxidase catalytic system, which does not produce peroxide; (2) the peculiar

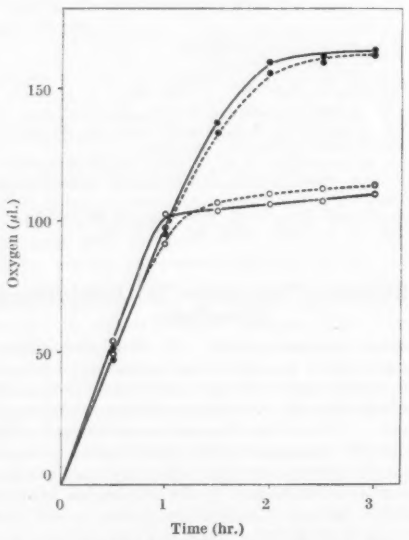


Fig. 1. Coupled oxidation of glutathione with pyruvate: with (dotted line) and without (full line) added catalase. ○, Oxygen uptake of glutathione alone. ●, Oxygen uptake of glutathione plus pyruvate. Glutathione, 0·02 m.mol.; pyruvate, 0·04 m.mol.; cupric chloride, 0·0002 m.mol.; crystalline catalase (Kat. f. = 17,700), 0·2 mgm. phosphate buffer 0·067 *M*, *p*H 7·4, 1 ml., plus 0·4 ml. 0·1 *N* sodium hydroxide. Total vol. 3 ml. Temp. 38°. Final *p*H, 8·4

Table 1. COUPLED OXIDATION OF KETO-ACIDS BY GLUTATHIONE AND THE EFFECT OF CATALASE

Experimental conditions as in Fig. 1. Values in μl. oxygen exceeding the oxygen uptake of glutathione without the added keto-acid. Time of experiment: at exhaustion of oxidation (3–4 hr.)

Keto-acid	Extra oxygen uptake: without catalase	with catalase
Pyruvic acid	51	47
Phenylpyruvic acid	42	43
α-Keto butyric acid	36	29
α-Keto *iso*valeric acid	13	13
α-Keto *iso*caproic acid	12	12
Mesoxalic acid	80	76
α-Keto glutaric acid	23	21
α-Keto adipic acid	5	6

behaviour of cysteine, which, forming a thiazolidine ring with pyruvate, is effective only in part, presumably in the form of an addition product; (3) the known ability of mercaptans to give hemimercaptols with carbonyl functions; (4) the actual production of a complex between glutathione and pyruvate in our conditions.

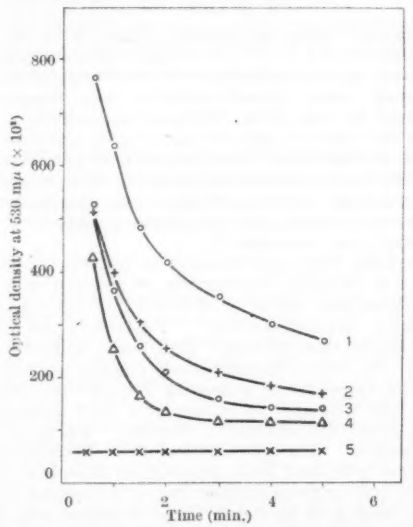


Fig. 2. Nitroprusside reaction of glutathione in the presence of different amounts of pyruvate. Conditions as in Fig. 1, with cupric chloride omitted. (1) Glutathione alone; (5) nitroprusside alone; (2), (3), (4), as (1) with 0·02, 0·04, 0·1 m.mol. respectively of added pyruvate. At zero time, 0·2 ml. of 25 per cent nitroprusside was added to the test solution

At present, since the discovery of coenzyme A and lipoic acid, and of all the reactions leading to the oxidative decarboxylation of pyruvate, the resemblance between the coupled oxidation of glutathione with keto-acids and their biological oxidation by thiamine derivatives is, of course, out of date. Nevertheless, some biological oxidations seem to follow this path[7].

D. CAVALLINI
G. F. AZZONE
F. STIRPE

Institute of Biological Chemistry,
University of Rome. Feb. 6.

[1] Cavallini, D., *Biochem. J.*, **49**, 1 (1951).
[2] Slater, E. C., *Nature*, **170**, 970 (1952).
[3] Cavallini, D., *Arch. Fisiol.*, **45**, 189 (1946).
[4] Racker, E., *Biochim. Biophys. Acta*, **9**, 577 (1952).
[5] Schubert, M. P., *J. Biol. Chem.*, **114**, 341 (1936).
[6] Keilin, D., and Hartree, E. F., *Biochem. J.*, **39**, 293 (1945).
[7] Strittmatter, P., and Ball, E. G., *J. Biol. Chem.*, **213**, 445 (1955).

Anticoagulant Specificity and Physiologically Inactive Beta-Prothromboplastin

A SMALL number of hæmophilic patients at first benefit by blood or plasma transfusions but later develop in their blood an anticoagulant which renders further transfusions temporarily ineffective. It is believed that the anticoagulant is an antibody due to the transfused antigen[1], but positive precipitin tests have been obtained infrequently.

A seven-year old boy, *MJ*-1, whose plasma was completely deficient in β-prothromboplastin (*P.T.C.*[2] or Christmas-factor[3]) had received nine blood transfusions. When examined by us for the first time nine months after the last transfusion, his plasma contained a potent anticoagulant which inhibited the formation of blood thromboplastin. It was thought that the anticoagulant was active against β-prothromboplastin, but serological tests were negative and the following procedure was developed: β-prothromboplastin from plasma or serum was adsorbed on barium sulphate suspension. The adsorbate was washed with 0·15 *M* sodium chloride until free of protein and drained. To the deposit 1 ml. of the isolated anticoagulant from plasma of *MJ*-1 was added and stirred frequently for 1 hr. at room temperature. The supernatant was tested for anticoagulant activity with a thromboplastin generation test[4] or by thrombin formation[5]. The results obtained are given in Table 1.

Table 1. MODE OF ACTION AND SPECIES SPECIFICITY OF AN ANTICOAGULANT AGAINST BETA-PROTHROMBOPLASTIN

Anticoagulant treated with barium sulphate adsorbate prepared from:	Remaining activity as percentage of original anticoagulant
(*A*) Untreated barium sulphate suspension	100
(*B*) Normal human oxalated plasma	44, 39, 23, 32, 34, 28
(*C*) Normal human oxalated plasma free of β-prothromboplastin	100
(*D*) Normal human serum	32
(*E*) Normal rabbit plasma	76
(*F*) Congenital β-prothromboplastin deficiency (*MB*-1)	100
(*G*) Congenital β-prothromboplastin deficiency (*MA*-2) 51 and 69 days after plasma transfusion	49, 50
(*H*) Congenital β-prothromboplastin deficiency (*MD*-1) 36 months after blood transfusion	92

From these results, it is seen that the anticoagulant reacts specifically with β-prothromboplastin of human origin (*B* and *D*), but shows little activity with that of rabbit's plasma (*E*). The anticoagulant is not removed by barium sulphate adsorbate prepared from human plasma which has been freed artificially of β-prothromboplastin (*C*).

Barium sulphate adsorbates were prepared from plasma of several patients (*F*, *G*, *H*). *MJ*-1 and *MA*-2 do not suffer from different deficiencies because admixture of their plasma freed of inhibitor did not result in any correction of the clotting deficiency. *MB*-1 has never had a blood transfusion; *MA*-2 and *MD*-1 had received a number of blood plasma and serum transfusions which were always beneficial to them clinically, and laboratory tests showed no evidence of an inhibitor in their blood. Whereas barium sulphate adsorbates prepared from plasma of patients *MB*-1 and *MD*-1 removed little or no anticoagulant activity (*F* and *H*)—as expected—the barium sulphate adsorbates prepared from plasma of *MA*-2 removed 50 per cent of anticoagulant activity; which is only a little less than that removed by normal plasma adsorbates. This puzzling finding cannot be due to transfused β-prothromboplastin, because it was not detectable by coagulation studies.

Patients who have prothromboplastin deficiencies present instances of genetically determined abnormalities of protein synthesis. Our observations suggest the following conclusions. It seems that a proportion of such patients can produce substances closely related to the prothromboplastins in their antigenic properties but which are inactive in the formation of blood thromboplastin. Other patients are unable even to produce a prothromboplastin with antigenic properties or physiological activity. Because of this they are the most likely ones to develop antibodies following the transfusion of the particular prothromboplastin they lack. The adsorbate technique shows to which of these two groups a patient belongs. These ideas are in agreement with the observation that only a fraction of hæmophilics develop anticoagulants and that these suffer severe clinical disease, thus implying that they have a complete prothromboplastin deficiency[6].

Complete clinical and laboratory studies will be reported elsewhere. This investigation was carried out with the financial support of the National Health and Medical Research Council of Australia.

P. Fantl
R. J. Sawers

Baker Medical Research Institute and
Alfred Hospital Clinical Research Unit,
Melbourne.
Feb. 14.

[1] Craddock, C. S., and Lawrence, J. S., *Blood*, **2**, 505 (1947).
[2] Aggeler, P. M., White, S. G., Glendening, M. B., Page, E. P., Leake, T. B., and Bates, G., *Proc. Soc. Exp. Biol. Med.*, **79**, 162 (1952).
[3] Biggs, R., Douglas, A. S., MacFarlane, R. G., Dacie, J. V., Pitney, W. R., Merskey, C., and O'Brien, J. R., *Brit. Med. J.*, ii, 1378 (1952).
[4] Bell, W. N., and Alton, H. G., *Nature*, **174**, 880 (1954).
[5] Fantl, P., *Aust. J. Exp. Biol. Med. Sci.*, **32**, 853 (1954).
[6] Frommeyer, W. B., Epstein, R. D., and Taylor, F. H. L., *Blood*, **5**, 401 (1950).

Action of Chlorpromazine on Oxidative Phosphorylation of Liver and Brain Mitochondria

Investigations of recent years have shown that mitochondria, irrespective of their source, are the site of oxidative phosphorylation; but it is not known to what extent the metabolism of these structural units is specific for a particular organ.

We wish to report on the difference in action of chlorpromazine (10-(3-dimethylaminopropyl)-2-chlorphenothiazine) on oxidative phosphorylation in mitochondria from liver and brain, and on some properties of these particles from the two organs observed in the course of this work (cf. ref. 1). The mitochondria from liver were prepared according to, and from brain by a modification of, the method of Schneider[2]. Chlorpromazine inhibited the phosphorylation accompanying the oxidation of rat liver mitochondria with α-ketoglutarate, succinate, glutamate and pyruvate + malate as substrates, whereas it did not do so with mitochondria from rat brain cortex (Table 1). Essentially the same results were obtained with particles from guinea pig and monkey brain cortex. 2,4-Dinitrophenol was effective in suppressing phosphorylation with mitochondria from both organs.

In order to investigate the site of uncoupling by chlorpromazine, phosphorylation resulting from the oxidation of cytochrome *c* was studied with ascorbic acid or adrenaline as substrates according to the procedure of Maley and Lardy[3]. Table 2 shows that the presence of 2×10^{-4} *M* chlorpromazine uncoupled oxidative phosphorylation with liver mitochondria. In some cases phosphorylation was completely inhibited by the drug, whereas the oxidation was either the same or greater than that of the controls. When the experiment was repeated with mitochondria from rat brain cortex in the absence of chlorpromazine, little, if any, phosphorylation was obtained with cytochrome *c* and either ascorbate or adrenaline, but oxidation was unimpaired.

Table 1. Effect of Chlorpromazine on Oxidative Phosphorylation of Mitochondria from Liver and Brain Cortex (Rat)

	Liver			Brain		
	ΔP (μmoles)	O (μatoms)	P : O	ΔP (μmoles)	O (μatoms)	P : O
α-Ketoglutarate	29·3	10·4	2·8	7·9	2·6	3·0
α-Ketoglutarate + chlorpromazine	21·9	11·6	1·9	6·6	2·2	3·0
Succinate	24·9	11·3	2·2	8·2	5·0	1·6
Succinate + chlorpromazine	12·1	10·5	1·1	7·1	4·6	1·5
Pyruvate + malate	20·7	8·2	2·5	14·7	5·5	2·7
Pyruvate + malate + chlorpromazine	13·2	7·5	1·7	15·1	5·5	2·8
Glutamate	31·3	13·4	2·3			
Glutamate + chlorpromazine	19·8	11·6	1·7			

The reaction vessels contained (in μmoles): phosphate buffer, *p*H 7·4, 60; magnesium sulphate, 20; adenosine triphosphate, 6·5; cytochrome *c*, 0·02; sodium fluoride, 10–15; substrate; mitochondrial suspension, 0·5 ml. (average nitrogen, 1·3 mgm.); glucose, 50; hexokinase (Pabst), 0·4 mgm.; and potassium chloride solution (0·15 *M*) to a final volume of 3 ml. (when brain mitochondria were used, diphosphopyridine nucleotide at 0·2 mgm. per flask was added). Levels of substrates: α-ketoglutarate, 30; succinate, 30; glutamate, 60; pyruvate, 60 + malate, 3. Chlorpromazine = 2×10^{-4} *M*. Temperature 37° for liver, 30° for brain; incubation, 20–30 min. in air.

Exposing liver mitochondria to hypotonic sucrose with low levels of cytochrome *c*[4] resulted in phosphorus/oxygen ratios of 0·5–0·8 for the one-step oxidative phosphorylation. Practically no phosphorylation was obtained with brain mitochondria under the same experimental conditions. (Phosphorus/oxygen ratios averaging 0·1 (50 min. incubation) were obtained in experiments with commercial horse heart cytochrome *c* (Sigma). Upon column purification[5], this cytochrome *c* or cytochrome *c* prepared from beef brain gave higher phosphorylation values (phosphorus/oxygen ratios averaging 0·25), which were still far below those obtained with liver mitochondria.)

The observation that chlorpromazine appeared to uncouple oxidative phosphorylation in liver at the cytochrome *c* step was further supported by preliminary findings that the drug had no effect on phosphorus/oxygen ratios when ferricyanide was used as the electron acceptor. The failure of chlorpromazine to affect brain cortex mitochondria may be connected with their poor utilization of external

Table 2. Phosphorylation Coupled to the Oxidation of Cytochrome *c*

Ascorbic acid (30 μmoles)			2×10^{-4} *M* chlorpromazine		
ΔP (μmoles)	O (μatoms)	P : O	ΔP (μmoles)	O (μatoms)	P : O
5·3	6·5	0·81	3·1	6·9	0·45
3·4	6·8	0·50	0	7·6	0
4·9	4·9	1·0	1·1	5·1	0·22
Adrenaline (10 μmoles)					
5·8	5·8	1·16	0	4·9	0
4·6	5·6	0·82	0	7·4	0

The reaction vessels contained in addition (in μmoles): adenosine triphosphate, 6; phosphate buffer, *p*H 7·4, 30; magnesium sulphate, 30; sodium fluoride, 40; cytochrome *c* (Sigma), 0·3; glucose, 40; hexokinase, 0·4 mgm.; liver mitochondrial suspension, 0·5 ml. (average nitrogen, 1·7 mgm.); and sucrose solution (0·25 *M*) to a final volume of 3·0 ml. Gas phase, air; incubation at 30° with adrenaline for 10 min., with ascorbic acid 20 min.

cytochrome *c* for oxidative phosphorylation. This may point to a basic difference in the surface configuration of these structural elements of liver and brain cells. It may also be argued that the observed uncoupling of oxidative phosphorylation in liver mitochondria by chlorpromazine is secondary to the effect of the drug on mitochondrial structure.

This work was supported in part by grants from the United States Public Health Service, United Cerebral Palsy Association, Inc., and the Supreme Council, 33° Scottish Rite Masons of the Northern Jurisdiction, United States of America.

MAGDALENA BERGER
H. J. STRECKER
H. WAELSCH

New York State Psychiatric Institute, and
Department of Biochemistry,
College of Physicians and Surgeons,
Columbia University, New York.

[1] Berger, M., Symposium on Neurometabolism II (P. Hoeber, Chicago, 1955) (in the press).
[2] Schneider, W. C., *J. Biol. Chem.*, **176**, 259 (1948).
[3] Maley, G. F., and Lardy, H. A., *J. Biol. Chem.*, **210**, 903 (1955).
[4] Lehninger, A. L., ul Hassan, M., and Sudduth, H. C., *J. Biol. Chem.*, **210**, 911 (1955).
[5] Margoliash, E., *Biochem. J.*, **56**, 529 (1954).

Effects of Pituitary Growth Hormone on the Insulin and Hyperglycæmic-glycogenolytic Factor extractable from the Pancreas of Obese-Hyperglycæmic Mice

IN two separate experiments it has been found that, 24 hr. after the administration of bovine pituitary growth hormone to mice with the hereditary syndrome of obesity and hyperglycæmia (1 mgm. of growth hormone per mouse), changes had occurred in the amounts of insulin and hyperglycæmic-glycogenolytic factor extractable from the pancreas using a standardized acid alcohol technique[1]. In each experiment values for insulin and hyperglycæmic-glycogenolytic factor values were compared in the following four groups of animals (ten or twelve animals per group): obese-hyperglycæmic mice and their non-obese sibs treated with growth hormone, and two groups of the same description but not treated with growth hormone.

The growth hormone treatment resulted in significant rises of 37 and 169 per cent in the average (non-fasting) blood-sugar level in the groups of obese-hyperglycæmic mice above pre-injection non-fasting levels. For the hyperglycæmic-glycogenolytic factor assays, concentrations of test materials were measured on a logarithmic scale, and the above rises were associated with logarithmic increases in the factor of 1·52 and 2·42 respectively, relative to untreated obese controls. The insulin extractable from the pancreas decreased by 48 and 86 per cent in the two experiments. No consistent changes were observed in the hyperglycæmic-glycogenolytic factor or insulin extractable from the pancreas of the non-obese mouse following injection of growth hormone.

Rise of the concentration of glucose in pancreatic blood plasma results in increased release of insulin by the pancreas in the rat[2] and in the dog[3,4]. The fall in the extractable insulin of the pancreas which followed the rise in blood-sugar level in the obese-hyperglycæmic mouse, treated with growth hormone in our experiments, may signify that the pancreas of these animals is not able, following a sudden increase in demand, further to increase insulin production[5] to compensate for the increased rate of release. The alternative explanation for the fall in the extractable insulin, namely, that it resulted principally from decreased insulin production without increased insulin secretion, is not, in our opinion, so well supported.

Mice with the obese-hyperglycæmic syndrome have a turn-over of liver glycogen several times faster than their non-obese sibs[6] and have six times as much liver phosphorylase activity as their non-obese litter-mates (Shull, K. H., and Mayer, J., unpublished work). In view of Sutherland's findings concerning the action of hyperglycæmic-glycogenolytic factor on liver phosphorylase[7], these observations are consistent with the previously postulated hypothesis[8] of a hypersecretion of the factor in these animals. These obese mice are unusually sensitive to the hyperglycæmic action of growth hormone[9], which has been observed to cause the release of a hyperglycæmic factor by the pancreas in rats and cats[10] and in dogs[3]. In spite of apparent differences between the conditions of action of this agent and the extracted hyperglycæmic factor of pancreas[11], the hypothesis that growth hormone in the obese hyperglycæmic mouse leads to a rise in blood-sugar level due to a hyperglycæmic factor originating in the pancreas is still supported. The observed co-existent increase in the hyperglycæmic-glycogenolytic factor extractable from the pancreas apparently indicates that growth hormone administered to the obese hyperglycæmic mouse caused the rate of production of extractable hyperglycæmic-glycogenolytic factor to exceed its rate of disappearance from the pancreas. Experiments which are in progress will, perhaps, provide more information than is available at present on these processes.

D. W. CLARKE
G. A. WRENSHALL

Charles H. Best Institute,
University of Toronto.

J. MAYER

Department of Nutrition,
Harvard University,
Boston, Mass.

[1] Scott, D., and Fisher, A. M., *Amer. J. Physiol.*, **121**, 253 (1938).
[2] Anderson, E., and Long, J. A., *Endocrin.*, **40**, 92 (1947).
[3] Foa, P. P., Santamaria, L., Weinstein, H. R., Berger, S., and Smith, J. A., *Amer. J. Physiol.*, **171**, 32 (1952).
[4] Brown, E. M., Dohan, F. C., Freedman, L. R., DeMoor, P., and Lukens, F. D. W., *Endocrin.*, **50**, 644 (1952).
[5] Wrenshall, G. A., Andrus, S. B., and Mayer, J., *Endocrin.*, **56**, 335 (1955).
[6] Shull, K. H., and Mayer, J., *J. Biol. Chem.*, **218**, 885 (1956).
[7] Sutherland, E. W., *Ann. New York Acad. Sci.*, **54**, 693 (1951).
[8] Mayer, J., Andrus, S. B., and Sillides, D. J., *Endocrin.*, **53**, 572 (1953).
[9] Mayer, J., and Sillides, D. J., *Endocrin.*, **52**, 54 (1953).
[10] Bornstein, J., Reid, E., and Young, F. G., *Nature*, **168**, 903 (1951).
[11] Shull, K. H., and Mayer, J., *Endocrin.* (in the press). Sirek, O., Sirek, A., and Best, C. H., *Proc. Canad. Physiol. Soc.*, 19th annual meeting, 57 (October 1955).

Mechanism of Anorexia in Vitamin-deficient Hyperphagic Animals

RECENT findings[1] have demonstrated that the ventromedial hypothalamic nuclei act as 'satiety' brakes which, in response to certain stimuli (particularly metabolic), inhibit a constantly activated 'feeding' mechanism. This mechanism, in turn, appears to be initiated at the level of the anterolateral nuclei[2]. Destruction of the ventromedial nuclei does

not increase hunger (as measured by rate of ingestion); it shortens the pauses between 'meals' which, in normal animals, steadily increase during the day so as to constitute a 24-hr. feeding cycle marked with a definite 'satiety' pattern[1]. A method for the destruction of these centres in the rat[3], the mouse[4] and other species is through the use of stereotaxic instruments. In the mouse, it has also been shown recently[5] that administration of gold thioglucose leads to obesity through injury to the ventromedial nuclei. Such mice and 'hypothalamic' rats and mice can thus be used for elucidating whether vitamin deficiencies act by permanently activating the 'satiety' mechanism or by inactivating the 'feeding' mechanism. For example, one could visualize that thiamine deficiency, the anorexic effect of which is classic, permanently activates the ventromedial nuclei because of the constant elevation of blood concentration of intermediaries of carbohydrate metabolism, or inactivates the feeding mechanism through the action of toxic accumulation of noxious products or because of the lack of carboxylase *per se*.

The following experiment was carried out. Twenty-one adult female mice were studied; eleven of these were obese, having been made hyperphagic by a single intraperitoneal injection (1 mgm./gm.) of gold thioglucose 147 days previously. The mean weight of these eleven hyperphagic mice was 50 gm. (range 40–63 gm.), and that of the ten controls was 32 gm. (range 29–36 gm.). All the mice were fed a synthetic diet[6] plus essential vitamins for a conditioning period of twelve days; then the eleven hyperphagic mice were fed restricted amounts of this diet so that after a restriction period of fourteen days their weights (mean 33 gm., range 31–34 gm.) approximated to those of the non-hyperphagic controls. At this point, half the control mice and six of the eleven hyperphagic mice were fed a thiamine-deficient diet until there were no survivors; the other controls and the other five hyperphagic mice being fed the diet plus thiamine for the same period.

The hyperphagic thiamine-deficient mice died earlier ($20{\cdot}5 \pm 4{\cdot}4$ days) than the non-hyperphagic thiamine-deficient controls ($24{\cdot}2 \pm 2{\cdot}6$ days); this difference was statistically significant ($p < 0{\cdot}05$ but $> 0{\cdot}02$). By the time the last of the mice receiving the thiamine-deficient diet had died, the hyperphagic mice that had been fed the diet plus thiamine had returned to approximately the same weights as previously, their mean weight at the end of the experiment being 52·4 gm. (range 40–61 gm.).

It is clear from the results that, in this case, the hyperphagic tendency of the gold thioglucose animals was instantly eliminated by the deficiency. Indeed, the deficiency—and the anorexia—were in effect earlier in these animals than in their controls, doubtless because for a few days the caloric intake of the hyperphagic animals was greater, thus increasing the requirement[7]. In view of the absence of functional 'satiety' tissue[5], the deficiency must have caused anorexia through direct inactivation of the 'feeding' mechanism.

The specificity of this effect of thiamine deficiency is further demonstrated by the following experiment involving a chronic deficiency of vitamin A. Requirement for this vitamin is not related to caloric intake[8], nor is decrease in food intake the earliest observable effect of the deficiency[9]. Sixteen 21-day old female rats were placed at weaning on a vitamin A-deficient semi-synthetic diet[10] on which their mothers had been maintained during lactation. Eight controls received 1,200 I.U. of vitamin A per week whereas the experimental group received only one dose of 100 I.U. at weaning. Three and a half months later, this group exhibited a permanently keratinized vagina, eyelids partly denuded and red, and a body-weight steady at 50 gm. below the control-level. Both groups were subjected to hypothalamic lesions. In each group, five animals became markedly hyperphagic. In particular, in the deficient group, the five successfully operated animals increased their weights within the next two months by 70–200 gm. (maximum weight recorded 545 gm.). Having reached the maximum weight, the animals then lost weight and survived 1–2·5 months, a total survival no less and probably greater than that of unoperated deficient animals maintained in comparable conditions. Thus, in this type of deficiency, with presumably no direct effect on the feeding mechanism, removal of the satiety centres leads to marked and lasting hyperphagia. This observation would also suggest that considerable fat deposition can be accomplished in the face of advanced depletion of vitamin A, which would tend to preclude an active role for vitamin A in fatty acid synthesis.

The experiments reported above indicate that the use of hyperphagic animals in nutritional deficiency studies can permit the beginning of an analysis of the mechanism of the anorexia associated in various degrees with many of them.

L. R. C. Agnew
Jean Mayer

Department of Nutrition,
Harvard School of Public Health,
Boston, Mass.
Jan. 31.

[1] Anliker, J. E., and Mayer, J., *Amer. J. App. Physiol.* (in the press).
[2] Anand, B. K., and Brobeck, J. R., *Yale J. Biol. Med.*, **24**, 141 (1951).
[3] Hetherington, A., *Amer. J. Physiol.*, **133**, 326 (1941).
[4] Mayer, J., French, R. G., Zighera, C. Y., and Barnett, R. J., *Amer. J. Physiol.*, **182**, 75 (1955).
[5] Marshall, N. B., Barnett, R. J., and Mayer, J., *Proc. Soc. Exp. Biol. Med.*, **90**, 240 (1955).
[6] Agnew, L. R. C., *Proc. Soc. Exp. Biol. Med.*, **90**, 452 (1955).
[7] Cowgill, G. R., *Amer. J. Physiol.*, **98**, 598 (1931).
[8] Goss, H., and Guilbert, H. R., *J. Nutrition*, **18**, 177 (1939).
[9] Mayer, J., and Krehl, W. A., *Yale J. Biol. Med.*, **40**, 403 (1948).
[10] Mayer, J., and Krehl, W. A., *J. Nutrition*, **35**, 523 (1948).

Lactose as a Lipotropic Agent

Incorporation of a small amount of lactose in the diet of young albino rats increases their food intake and they grow better than the control rats fed on sucrose. This increased food intake leads to greater weight and increased fat content of their liver and kidney[1]. If the food intake of lactose-fed rats is equalized to that of the sucrose-fed rats by the paired-feeding technique, the liver and kidney fat content decreases in the lactose-fed rats.

A batch of forty-eight young albino rats weighing 30–35 gm. was divided into four groups, one group receiving a lactose-free complete diet with added cystine (casein 15, sucrose 58, coconut oil 15, salt mixture 4, cod-liver oil 5, cystine 0·4 and vitamin mixture except choline), and the other three groups receiving the same diet except for the partial replacement of sucrose by 10, 20 and 30 per cent lactose.

Table 1. Distribution of choline, sphingomyelin, lecithin, cephalin and phospholipid (in mgm./gm.) of wet weight of tissue and fat per cent in rats fed different amount of lactose (C_1, C_2, C_3 groups receiving 10, 20, 30 per cent lactose) as compared with that of sucrose-fed rats (C_0 group)

Analysis	Liver				Kidney			
	C_0	C_1	C_2	C_3	C_0	C_1	C_2	C_3
Choline	1·32	2·02	2·31	2·51	1·57	2·04	2·57	2·75
Sphingomyelin	0·75	0·69	0·50	0·41	0·91	0·75	0·58	0·44
Lecithin	8·0	12·7	14·9	16·3	9·5	12·8	16·5	17·9
Cephalin	8·9	8·3	12·8	10·3	11·9	13·7	14·9	12·2
Phospholipid	16·9	21·0	25·6	26·6	21·4	26·5	29·8	30·1
Fat (per cent)	11·3	10·1	10·4	9·7	12·4	10·4	10·4	9·8

All the lactose-fed rats were pair-fed with the C_0 group eating the sucrose diet. After four weeks of experimental feeding they were killed and livers and kidneys analysed for fat, choline, phospholipid and sphingomyelin[2] (see Table 1).

The lactose-fed rats had greater choline and phospholipid and less fat and sphingomyelin content in liver and kidney. This experiment shows that lactose not only acts as a sparer of choline, but also as a lipotropic agent by virtue of this effect, provided the food intake is controlled to the same level. This has an important bearing on the kwashiorkor syndrome, where lack of milk and absence of lactose in the diet of the young after early weaning may be responsible for the fatty liver, which is caused as a result of the lack of choline-sparing and lipotropic effects of lactose. The mechanism of increased food intake in lactose diet is being investigated.

I am indebted to Dr. S. Datta, director of veterinary services and animal husbandry, West Bengal, for his interest and valuable suggestions.

D. P. Sadhu

Department of Physiology and Nutrition,
Bengal Veterinary College,
Calcutta 37.
Jan. 28.

[1] Sadhu, D. P., *Ind. J. Physiol. and Allied Sci.*, **9**, 156 (1955).
[2] Sadhu, D. P., *Amer. J. Physiol.*, **174**, 238; **175**, 283 (1953).

Utilization of the Carboxyl Carbon of L-Phenylalanine for the Synthesis of the Amino-acids of Silk by *Bombyx mori*

Previous observations in this laboratory concerning the content of free amino-acids in the silk gland of *Bombyx mori* seemed to indicate that silk alanine might be derived from phenylalanine. In order to check this possibility, it was decided to inject silkworms with L-phenylalanine labelled with carbon-14 in the carboxyl group, before they spin their cocoons.

The L-phenylalanine was prepared from glycine labelled with carbon-14 in the carboxyl group, following the method of Bergmann *et al.*[1]. Acetylglycine was allowed to react with benzaldehyde and the azlactone obtained was coupled with L-glutamic acid; the product of the reaction was hydrogenated and the acetyl-L-phenylalanyl-L-glutamic acid was separated by crystallization from the acetyl-D-phenylalanyl-L-glutamic acid. After hydrolysis of the acetyl-L-phenylalanyl-L-glutamic acid, the two amino-acids were separated on a starch column following Stein and Moore's procedure[2]. The radioactive L-phenylalanine was crystallized in water/ethanol and the purity checked by paper chromatography (phenol/water; butanol/*N* hydrochloric acid); Kjeldahl nitrogen analyses (8·61 per cent; theor., 8·48 per cent), and optical activity determination ($[\alpha]_D^{20} = -34·5°$, litt. $-35·1°$). The scanning of the paper chromatograms showed that the radioactivity was exclusively localized at the phenylalanine spots. That the radioactivity was indeed in the carboxyl group of the radioactive phenylalanine was shown by ninhydrin decarboxylation following the method of van Slyke *et al.*[3] (see Table 1).

0·2 mgm. of this carboxyl-labelled L-phenylalanine was injected into each of ten silkworms after they had stopped eating and were ready to spin their cocoons. It must be emphasized that, at this time, the silk glands are already swollen with secretion.

Fibroin was isolated from the ten cocoons, following the procedure described by Dunn *et al.*[4]. The fibroin was then hydrolysed by refluxing in 32 per cent hydrochloric acid for eight hours. The tyrosine, glycine and alanine were isolated following Stein and Moore's method[5].

The glycine was isolated as the *p*-azobenzene sulphonate and the alanine as the nitronaphthalene sulphonate; these sulphonates were recrystallized in water. The amino-acids were obtained by passing the sulphonates on an 'Amberlite' *IR*-120(H) resin and then eluting with 3 *N* ammonia; the amino-acids were crystallized in water/ethanol/ethyl ether and found to be chemically pure by paper chromatography (phenol/water; butanol/*N* hydrochloric acid) and Kjeldahl nitrogen analyses (18·75 per cent for the glycine and 15·75 per cent for the alanine; theor. 18·66 and 15·72 per cent respectively). Both glycine and alanine were radioactively inactive (Table 1).

The tyrosine was purified by starch chromatography following Stein and Moore's procedure[2]. The radioactivity of this purified tyrosine was determined, and the compound was found to be active. It was felt that it could not be precluded that the radioactivity of the tyrosine might be due to traces of the very radioactive phenylalanine that had been injected. To examine this possibility, ordinary phenylalanine was added to the purified tyrosine and the mixture separated by chromatography on a starch column. The eluted tyrosine was dissolved in sodium hydroxide solution and crystallized by addition of acetic acid to *p*H 5 and ethanol; the radioactivity was again measured and found to be slightly higher than previously; there was, moreover, no detectable radioactivity in the eluted phenylalanine. Both results show that the radioactivity of the tyrosine sample was not due to the contamination by carbon-14-phenylalanine and was most probably within tyrosine molecules. The chemical purity of the purified tyrosine was proved by paper chromatography

Table 1

	Specific activities*	
	Amino-acid (c./min./m.mole)	Carboxyl group of amino-acid (c./min./m.equiv.)
Injected L-phenylalanine	$13·6 \times 10^6$ $\sigma = 1$ per cent	$13·5 \times 10^6$ $\sigma = 1$ per cent
Silk glycine	0	
Silk alanine	0	
Silk tyrosine	$23·9 \times 10^3$ $\sigma = 1$ per cent	$23·8 \times 10^3$ $\sigma = 1$ per cent

* All determinations were performed on barium carbonate deposits.

(phenol / water; butanol / *N* hydrochloric acid) and Kjeldahl nitrogen analyses (7·75 per cent; theor. 7·73 per cent). The radioactivity of the isolated tyrosine was localized exclusively in the carboxyl group as it was entirely in the carbon dioxide evolved by ninhydrin decarboxylation (Table 1).

From these results, it is concluded that phenylalanine is converted to tyrosine by the silkworm and that the conversion is a fairly direct one, since the radioactivity was exclusively localized in the carboxyl group of the injected phenylalanine and the isolated tyrosine. About 15 per cent of the injected phenylalanine radioactivity was found in the tyrosine of the silk fibroin.

On the other hand, the carboxyl carbon of phenylalanine is not utilized for the synthesis of alanine or glycine of the silk by *Bombyx mori*; the tyrosine results make it very unlikely that the phenylalanine could not reach the site where such transformation occurs.

This work was nearly completed when Fukuda published results[6] showing that he had isolated radioactive tyrosine from silk after injection of 2-^{14}C-phenylalanine into silkworms; he found only a very small activity in glycine and alanine.

We wish to thank Ch. Jeuniaux for his help in looking after the silkworms and injecting them with the radioactive compound.

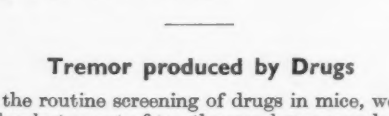
S. Bricteux-Grégoire
W. G. Verly
M. Florkin

Department of Biochemistry,
University of Liège.
April 25.

[1] Bergmann, M., Stern, F., and Witte, C., *Lieb. Ann.*, **449**, 277 (1926).
[2] Stein, W. H., and Moore, S., *J. Biol. Chem.*, **176**, 337 (1948).
[3] Van Slyke, D. D., Dillon, R. T., MacFadyen, D. A., and Hamilton, P., *J. Biol. Chem.*, **141**, 627 (1941). Van Slyke, D. D., MacFadyen, D. A., and Hamilton, P., *J. Biol. Chem.*, **141**, 671 (1941).
[4] Dunn, M. S., Camien, M. N., Rockland, L. B., Shankman, S., and Goldberg, S. C., *J. Biol. Chem.*, **155**, 591 (1944).
[5] Stein, W. H., and Moore, S., "Biochemical Preparations", **1**, 9 (Wiley, 1949).
[6] Fukuda, T., *Nature*, **177**, 429 (1956).

Tremor produced by Drugs

In the routine screening of drugs in mice, we have found only ten out of ten thousand compounds which produce sustained tremor. One of these, 1·4 di-pyrrolidino-2-butyne, 'Tremorine',



in doses of 5–20 mgm./kgm. produces tremor, salivation, meiosis, slight muscular weakness and rigidity lasting several hours. The effects are similar in mice, rats, guinea pigs, cats, dogs and monkeys. In the last-named species the picture is strikingly similar to human Parkinsonism. The antagonism of these effects is complete with various drugs used for treating Parkinsonism. Atropine, scopolamine and others are highly effective in small doses of 1–2 mgm./kgm. In contrast, hypnotics, anticonvulsants and ganglionic blocking agents were without effect on tremor in doses below those causing marked depression. It thus offers a specific method for the testing of possible anti-Parkinson agents.

Methantheline ('Banthine') controlled the parasympathetic signs of salivation and diarrhœa but had no effect on the tremor, demonstrating the distinct peripheral and central actions. The tremor appears to be primarily of subcortical origin. Decerebrate animals develop tremor after 'Tremorine'. The drug also causes a profound fall in body temperature. The chemical structure producing tremor is highly specific within this chemical type. Twenty analogues showed no such action. Other tremor-producing drugs are of widely diverse chemical structures. Nicotine tremor has been studied by Bovet *et al.*[1] and suggested as a test method for anti-Parkinson drugs. While this method is useful, the nicotine tremor is fleeting, has both central and peripheral components and is blocked by a number of drugs not effective in Parkinsonism[2]. Another drug, 'Harmaline', produces sustained tremors but no signs of parasympathetic involvement, and is not antagonized by a variety of anti-Parkinson drugs, blocking agents or sedatives.

It is hoped that the discovery of 'Tremorine' and its further study will reveal it to be a useful tool in the investigation of tremor and the search for more effective agents against Parkinsonism.

Guy M. Everett

Department of Pharmacology,
Abbott Laboratories,
North Chicago, Illinois.
April 30.

[1] Bovet, D., and Longo, V. G., *J. Pharmacol. and Exp. Therap.*, **102**, 22 (1951).
[2] Cahen, Raymond L., and Lynes, Thomas E., *J. Pharmacol. and Exp. Therap.*, **103**, 44 (1953). Cahen, Raymond L., Thomas, Joan M., and Tvede, Kristen M., *J. Pharmacol. and Exp. Therap.*, **107**, 424 (1953). Cahen, Raymond L., *Proc. Soc. Exp. Biol. and Med.*, **84**, 474 (1953).

Auto-oscillations in Extracted Muscle Fibre Systems

In the course of work on relaxing factors[1], Goodall and A. G. Szent-Györgyi[1] observed that with fibres showing less than maximal activity for the creatine phosphate – adenosine triphosphate relaxing system, an auto-oscillation of tension developed if the creatine phosphate was increased to 30–100 m*M*. These oscillations (Fig. 1) were observed on several occasions under the above conditions. They are independent of a *p*H change from 6·8 to 5·9 which produces a 50 per cent fall of tension, as compared to 90 per cent for 'active' fibres. However, it is not certain that this 'deactivation' is an essential part of the extraction procedure;

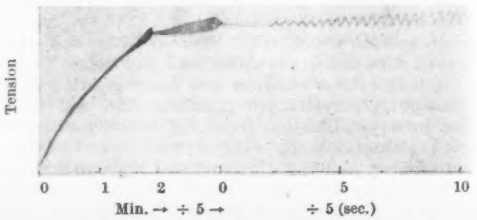


Fig. 1. Rabbit psoas muscle fibre extracted with 40 per cent ethylene glycol – water for seven days, developing oscillations in 4 m*M* adenosine triphosphate, 100 m*M* sodium creatine phosphate, 4 m*M* magnesium chloride, at *p*H 7·0. Drum-speed increased five times at each break in record

afterwards I found that 40 per cent ethylene glycol – water extraction at −5° C. produced oscillating fibres in a matter of a few days. The significant fact about such fibres appears to be their high elastic modulus.

The frequency, 2·8 sec.$^{-1}$, was 1·75 times the free oscillation of the recording lever alone, while with fibre coupled in the absence of substrate, it was about twice. Since, however, the elastic modulus falls by a factor of more than three times in the presence of adenosine triphosphate alone, it seems that the tension generator is driving the system somewhat above its natural frequency, that is, under conditions of inertial load. The compliance of the system was such that the shortening during one cycle was only 0·1 mm., or 0·3 per cent of the length of the fibre. Thus if the feedback mechanism works through length (rather than tension), only a small change is required.

The interest of this phenomenon would appear to be twofold. First, it closely resembles the situation in the flight muscles of insects, studied by Pringle[2] and Boettiger and Furshpan[3]. Secondly, it supports the hypothesis of a direct action of lengthening on activation in muscle, which has been proposed[4] as a result of a study of activation[5] in intact muscle, where it is shown that auto-oscillations can then occur only with an inertial load. In this connexion the latency relaxation of Sandow[6] was considered to be an expression of essentially the same mechanism.

Auto-oscillations with another phosphate donor system have been found by Lorand and Moos (personal communication; see following communication), whose extraction procedure is also effective with the creatine phosphate system.

This work was aided by a grant from the Muscular Dystrophy Association of America, Inc.

M. C. Goodall

Department of Zoology,
University of Michigan.
May 11.

[1] Goodall, M. C., and Szent-Györgyi, A. G., *Nature*, **172**, 84 (1953).
[2] Pringle, J. W. S., *J. Physiol.*, **124**, 269 (1954).
[3] Boettiger, E. G., and Furshpan, E., *J. Cell. Comp. Physiol.*, **46**, 370 (1955).
[4] Goodall, M. C., *Bull. Math. Biophys.* (in the press).
[5] Goodall, M. C., *J. Gen. Physiol.* (in the press).
[6] Sandow, A., *Ann. N.Y. Acad. Sci.*, **47**, 895 (1947).

In connexion with our studies on the relaxing effect of the pyruvate phosphokinase system[1], the following procedure was used for preparing the muscle fibres. Rabbit psoas is washed in 50 per cent (v/v) aqueous glycerol (as in the original treatment of Szent-Györgyi[2]) for two days at 0° C., then stripped into bundles of approximately ¼ mm. diameter and shaken at room temperature (about 25° C.) in 20 per cent (v/v) glycerol for various lengths of time. After one to two hours extraction, the fibres develop maximal isometric tension in a bath consisting of 0·1 *M* potassium chloride, 4 m*M* magnesium chloride, and 4 m*M* adenosine triphosphate, and there is no sign of spontaneous relaxation. However, addition of 10 m*M* phosphoenolpyruvate brings about immediate relaxation. Further details on the relaxation with phosphoenolpyruvate will be published elsewhere; here, we wish to report on the results obtained by extracting psoas fibres in 20 per cent (v/v) glycerol for at least 24 hr. If such an exhaustively washed fibre is placed in a bath containing the above concentrations of potassium and magnesium chlorides and adenosine triphosphate, maximal tension develops, and upon the addition of phosphoenolpyruvate a spontaneous oscillation occurs as shown in Fig. 1.

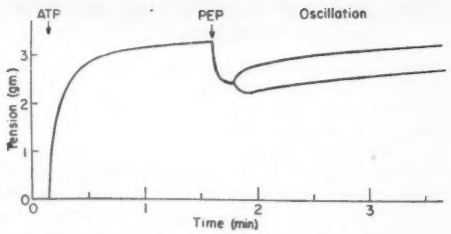


Fig. 1. Oscillating response of glycerinated psoas fibre in the presence of 0·1 *M* potassium chloride and 4 m*M* magnesium chloride. Bath at *p*H 7. ATP = addition of 4 m*M* final concentration of adenosine triphosphate. PEP = addition of 10 m*M* final concentration of phosphoenolpyruvate. Oscillation frequency, 2·8 c./s. Details are not resolved by slow kymograph drum. Double line represents envelope of oscillation

Phosphoenolpyruvate seems to be essential for maintaining the oscillation, as it stops if the fibre is transferred to a bath containing only potassium and magnesium chloride and adenosine triphosphate, but it starts anew in a bath having phosphoenolpyruvate as well. The frequency of oscillation is about 2·5–3 c./s., which in our case coincides approximately with the resonant frequency of the recording lever system loaded with the muscle fibre. In a batch of fibres washed in 20 per cent (v/v) glycerol for 24 hr., usually about 25 per cent of the fibres display the oscillating behaviour. An apparently identical phenomenon has been observed by Goodall (personal communication; see previous communication), who employed creatine phosphate instead of phosphoenolpyruvate.

By dialysing and freeze-drying the 20 per cent (v/v) glycerol solution used for the 24-hr. extraction of the muscle fibres, a preparation is obtained which stops the oscillations very effectively when added to the bath. Oscillations are resumed, however, if the fibre is transferred to a fresh bath without the muscle extract. An equally active preparation for stopping oscillations may be obtained by extracting freshly homogenized rabbit muscle with an equal volume of 0·15 *M* potassium chloride. The active factor (or factors ?) for inhibiting oscillation is non-dialysable and thermolabile.

This oscillation of glycerinated fibres is very reminiscent of the behaviour of the bumble bee wing muscle[3]. Indeed, one wonders if the oscillation observed in the insect muscles might not be due to the absence of a 'damping factor' similar to that shown here to exist in the rabbit psoas.

This work was aided by a grant from the Muscular Dystrophy Association of America, Inc.

L. Lorand
C. Moos

Department of Chemistry,
Northwestern University,
Evanston,
Illinois.

[1] Lorand, L., and Moos, C., *Fed. Proc.*, **15**, 121 (1956).
[2] Szent-Györgyi, A., *Biol. Bull.*, **96**, 140 (1949).
[3] Boettiger, E. G., *J. Cell. Comp. Physiol.*, **46**, 370 (1955).

Plasma Factor(s) influencing Red Cell Production

THERE is an accumulating body of evidence of the existence of a humoral substance(s) in the plasma of animals with induced anæmia which stimulates erythropoiesis in recipients[1].

We have found that when young adult rats are hypophysectomized by a standard technique (from Hormone Assay Laboratories, Inc., Chicago), erythropoiesis is reduced to a minimum by 10–14 days after the operation as shown by a tenfold reduction in the incorporation of iron-59 into the red cells and by a fivefold reduction in the number of reticulocytes. When this level of erythrocyte production is reached, the administration of plasma (2 ml. daily for three days) from rats made anæmic by repeated bleeding (anæmic plasma) results in a three- to seven-fold increase in the amount of iron-59 taken up by the erythrocytes (Table 1) and in a three- to eight-fold increase in the number of reticulocytes in the recipients. As previously described[2], the iron-59 solution is injected through the tail vein 2 hr. after the last plasma injection; 16 hr. later, a 1-ml. sample of blood is withdrawn from each rat and the radioactivity is counted in a well-type scintillation counter. No significant change is observed in the incorporation of iron-59 into the red cells of the control hypophysectomized rats given normal plasma or saline under these experimental conditions. The blood volume and red-cell mass of hypophysectomized rats, as determined by chromium-51 studies, remain within normal limits during this initial two-week period. A single intravenous or intraperitoneal injection of 2 ml. of anæmic plasma given 24 hr. before the injection of iron-59 elicits a significant increase in the incorporation of iron-59 into the red cells of hypophysectomized rats. Two injections of 2 ml. each of anæmic plasma from other species (for example, rabbit, dog or human being) evoke a positive erythropoietic response in the hypophysectomized rat. Six or more daily 2-ml. injections of normal rat plasma must be given to produce a definite increase in iron-59 taken up by the red cells of hypophysectomized recipients.

The plasma from hypophysectomized rats subjected to hæmorrhage (hæmatocrit less than 25 per cent) exerts an effect on the uptake of iron-59 in hypophysectomized rats that is comparable with that observed after the administration of anæmic plasma.

At this stage of our investigations we prefer not to debate the question raised by others as to whether there is a specific pituitary factor that has a direct control on erythropoiesis; but it is an established fact that the red-cell mass falls slowly to a new equilibrium-level within a period of two to three months after hypophysectomy[3].

The simplest explanation for our findings may be summarized as follows: Within a few days after hypophysectomy, an overall reduction occurs in the metabolic processes of the animal. With the reduced metabolic requirement and before the red-cell mass has fallen to its new level of equilibrium, the hypophysectomized animal is more or less comparable to an animal that has been made polycythæmic by red-cell transfusion. It may be postulated that, in these circumstances, the production of the plasma factor(s) responsible for maintenance of the steady state of circulating erythrocytes is reduced to a minimum since a plethora of red cells already exists. Thus, there is a situation that in essence is the reverse of that which obtains when a normal animal is bled. As a consequence, red-cell production is reduced to a minimum. When anæmic plasma is administered under these conditions, there is an exaggerated response in terms of the production of new red cells. As final and complete equilibration of red-cell production and the new reduced red-cell mass slowly become established in the hypophysectomized animal, one finds, as would be expected, that the number of reticulocytes and the uptake of iron-59 have risen from the low values found shortly after hypophysectomy to values that are consistent with the new steady state. As reported by others[4], we have found that producing a polycythæmia in normal animals (mice, rat, rabbit) by repeated transfusion of red cells reduces erythrocyte production. The response to anæmic plasma in these polycythæmic animals in terms of the incorporation of iron-59 into the red cells or the increase in reticulocyte values is comparable with that observed in hypophysectomized animals.

Table 1. UPTAKE OF IRON-59 BY ERYTHROCYTES OF HYPOPHYSECTOMIZED RATS AFTER ADMINISTRATION OF NORMAL OR ANÆMIC PLASMA

Average percentage iron-59 uptake into red-blood cells of rats*				
Plasma injected	No. of animals	Prior to hypophysectomy	No. of animals	10 days post-hypophysectomy
Normal	8	37	17	3·7 ± 2†
Anæmic	5	48	16	20·4 ± 6†

* 16-hr. sample. † Standard deviation of the mean.

Note: While the number of animals prior to hypophysectomy is small, the results are in excellent agreement with those reported on a large number of rats (see ref. 2) when the sampling time was 20 hr.

We assume for the sake of simplicity that the factors in normal plasma and in the plasma of normal or hypophysectomized animals subjected to bleeding that stimulate erythropoiesis in hypophysectomized and in polycythæmic assay preparations are one and the same. Further study may, however, reveal a somewhat more complicated picture. Nevertheless, with this sensitive assay method, it should be possible to make more rapid progress in determining the source, the identity, and the physiological role of the plasma factor(s) under discussion in conditions of health and disease. Our studies will be published in detail elsewhere.

L. O. JACOBSON
L. PLZAK
W. FRIED
E. GOLDWASSER

Argonne Cancer Research Hospital and
Departments of Medicine and Biochemistry,
University of Chicago,
Chicago, Illinois. May 14.

[1] Grant, W. C., and Root, W. S., *Physiol. Rev.*, **32**, 449 (1952). Erslev, A., *Blood*, **8**, 349 (1953).
[2] Plzak, L. F., Fried, W., Jacobson, L. O., and Bethard, W. F., *J. Lab. Clin. Med.*, **46**, 671 (1955).
[3] Van Dyke, D. C., Contopoulos, A. N., Williams, B. S., Simpson, M. E., Lawrence, J. H., and Evans, H. M., *Acta Haematologica*, **11**, 203 (1954).
[4] Robertson, O. H., *J. Exp. Med.*, **26**, 221 (1917).

Embryology, Epigenetics and Biogenetics

IN his stimulating review of Prof. C. H. Waddington's "Principles of Embryology", Dr. Julian Huxley[1] expresses the hope that Prof. Waddington will write a sequel, and, following his earlier impulse, call it "Principles of Epigenetics". While the term 'embryology' suggests a field far more restricted than that which this department of science is now concerned

with, the suggested alternative, 'epigenetics', has disadvantages of another kind. It still reverberates with the overtones of a *cause célèbre*, a controversy in which, as it now appears, neither 'epigenesis' nor 'preformation' gained a decisive victory. For whereas identifiable organized units, whether organs or tissues, appear successively from an apparently undifferentiated mass, there is now no question but that the material determinants of these new structures are preformed in the chromosomes recognizable before the beginning of embryonic life. That this caution is not a matter of mere historical pedantry is evidenced by the fact that another worker of long experience in this field, M. Jean Rostand, has recently[2] referred to the "extravagances du préformationnisme" and the "naïvetés de l'épigenèse".

In another place[3] I made the suggestion that the whole field comprising the problems of the 'genesis' of organisms could appropriately be styled as 'biogenetics', with subdivisions, 'ontogenetics' (the development of individual organisms), 'phylogenetics' (theories of descent) and 'stoichiogenetics' (quantitative 'genetics' *sensu strictu*), thus bringing out the unitary character of the field. It seems highly regrettable that no one was looking when those responsible for launching the new discipline concerned with the sub-field of the relation between adult 'characters' and transmitted determinants arrogated to it the higher-level name of 'genetics'. Whence my suggestion that, despite the high authority of the sponsors of the term 'epigenetics', the latter should not be too hastily accepted.

WILLIAM P. D. WIGHTMAN
Department of History and
Philosophy of Science,
University of Aberdeen.

[1] Huxley, *Nature*, **177**, 807 (1956).
[2] Rostand, *J. World Hist.*, **2**, 134 (1954).
[3] Wightman, *J. World Hist.*, **2**, 734 (1955).

THE fact that the word 'epigenetics' is reminiscent of 'epigenesis' is to my mind one of the points in its favour. As Dr. Wightman points out, in the old controversy, now stilled, between the theories of epigenesis and preformationism, neither side emerged completely victorious. We all realize that, by the time development begins, the zygote contains certain 'preformed' characters, but that these must interact with one another, in processes of 'epigenesis', before the adult condition is attained. The study of the 'preformed' characters nowadays belongs to the discipline known as genetics; the name 'epigenetics' is suggested for the study of those processes which constitute the epigenesis which is also involved in development. Admittedly the word 'genetics', which was coined by Bateson to cover "the physiology of descent", might have been used so as to embrace both aspects of development; but in practice it has not been widely employed in that sense.

Incidentally, it was not entirely from diffidence, as Huxley suggested, that I named my book the "Principles of Embryology"; I did so mainly because it devotes some space to the descriptive anatomical data relating to development, and is not confined wholly to that analysis of causal mechanisms for which the name 'epigenetics' is appropriate.

C. H. WADDINGTON
Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.

Effect of Some White Pigments on the Actinic Degradation of Cotton

THE action of solar radiation in reducing the strength of cotton is well known. In our experience, 12-oz. grey cotton duck exposed to weather in a non-industrial atmosphere near Melbourne, Victoria, loses about 25 per cent of its strength in twelve months, due solely to the action of light. Although fungal growth is commonly observed on exposed cotton fabrics, the species isolated have always been non-cellulolytic; fibres from exposed fabrics when examined microscopically by the modified congo red test[1] show actinic damage but no fungal damage.

The rotproofing treatments customarily applied in Australia to cotton duck intended for use in tentage are based on copper compounds all of which accelerate actinic action[2]. Fabrics treated with copper soaps and cuprammonium solutions may lose 70–80 per cent of their strength during twelve months exposure; copper naphthenate and copper 8-quinolinolate are less severe in their effects, but fabrics treated with them lose 40–50 per cent of their strength in that time. To reduce the effects of the copper compounds, Australian rotproofed tentage fabrics are given a protective pigment coating. Iron and chromium pigments have generally been used; but there is some demand for a white as well as a coloured finish. Zinc oxide has been tried; but it is difficult to incorporate in the coating emulsions used and it gives a grey colour rather than white. Other white pigments are easily incorporated in synthetic resin emulsions, and limited trials were arranged to determine the effect of the pigments that could be used in this way, the pigments being used singly or in mixtures.

The pigments were incorporated in synthetic resin emulsions and the various emulsions applied to 12-oz. grey cotton duck. The treated fabrics were exposed for twelve months (June 1954–May 1955) at Reservoir, near Melbourne, in a non-industrial atmosphere.

Table 1

Pigment used in emulsion	Chemical analysis of unexposed fabrics				Loss of strength after 12 months exposure (per cent)
	$BaSO_4$ (per cent)	ZnS (per cent)	TiO_2 (per cent)	Other (per cent)	
Series I					
Lithopone (30 per cent)	2·4	1·1	—	—	29
Lithopone (60 per cent)	1·2	1·1	—	—	38
Anatase	—	—	2·8	—	93
Rutile *A*	—	—	3·6	—	2
Antimony oxide	—	—	—	Sb_2O_3: 3·8	24
White lead	—	—	—	Pb: 2·8	26
Zinc sulphide	—	3·5	—	—	38
Series II					
Lithopone (60 per cent)	1·3	1·2	—	—	29
Lithopone and anatase	1·0	0·8	0·2	—	68
Lithopone and anatase	0·6	0·6	0·8	—	81
Anatase	—	—	3·3	—	87
Lithopone and rutile *A*	1·4	1·2	0·2	—	31
Lithopone and rutile *A*	0·8	0·6	0·8	—	15
Rutile *A*	—	—	3·2	—	5
Lithopone and rutile *B*	1·2	1·1	0·2	—	20
Lithopone and rutile *B*	0·7	0·7	0·8	—	14
Rutile *B*	—	—	3·4	—	4
Untreated	—	—	—	—	27

The pigments used, the results of chemical analyses of the unexposed fabrics, and the losses of breaking strength after exposure, are set out in Table 1.

The effect of anatase is startling. Fabrics containing about 3 per cent of this pigment lost 90 per cent in strength. Lithopone alone has only a slight effect on the loss of strength, but when small amounts of anatase are added the loss of strength is greatly increased. On the other hand, the presence of rutile retards the loss of strength. The other pigments used have little or no effect.

Fibres from the exposed materials examined by the congo red test showed varying degrees of actinic degradation but no damage from other causes. The intensity of the staining of the fibres increased with increasing loss of strength. The fabrics containing rutile showed only the faintest signs of actinic action; but all the fabrics containing anatase showed severe actinic damage.

These results indicate that anatase accelerates the actinic degradation of cotton and that rutile has a protective effect. The effect of anatase on cotton is consistent with its effect on fibres such as nylon and 'Perlon'. We have recently examined some deteriorated fabrics made from these fibres in which anatase had been used as a delustrant. Exposure of the fabrics to sunlight for a short time (about three months) had produced great losses of strength; this effect does not occur with bright (undelustred) nylon. The different effects of anatase and rutile in paints exposed to weather are well known[3]; paints containing anatase chalk rapidly and heavily, but paints containing rutile chalk only very slowly. We suggest that this may be due to the different reactions of the two pigments to light, and may be similar to the differences observed in Australia between chalking and non-chalking grades of zinc oxide[4]. The generally accepted explanation of the different effects is based on deficiencies in the spatial arrangement of the oxygen atoms in the crystal, whereby anatase can be reduced in the presence of oxidizable compounds; light provides the necessary stimulus for the reduction and atomic oxygen is liberated and attacks the oxidizable material. Cellulose can be readily oxidized with accompanying loss of strength, and it appears that the accelerating effect of anatase on the actinic degradation of cotton could be explained in the same way.

This communication is published with the permission of the Chief Scientist, Department of Supply, Australia.

W. R. Hindson

Defence Standards Laboratories,
Melbourne, Australia.

P. G. Kelly

Brella Fabric Finishing Co. Pty., Ltd.,
Reservoir, Victoria.
Feb. 1.

[1] Young, F. S., and Hindson, W. R., Defence Standards Laboratories, Department of Supply, Australia, Report 176 (1949).
[2] Hindson, W. R., Defence Standards Laboratories, Interim Report (1949).
[3] Schofield, M., *Paint Manuf.*, **17**, 386 (1947).
[4] Morley-Smith, C. T., *J. Oil Col. Chem. Assoc.*, **33**, 484 (1950).

A Gas Phase in Viable Fungal Spores

When the dark ascospore of *Sordaria fimicola* is examined dry, a round paler zone in the middle is invariably seen. If the spore is flooded with water, it is clear that this zone is a gas bubble which disappears in a few minutes. If the spore is again allowed to dry, very shortly after the last visible trace of external water has disappeared, a tiny intracellular gas bubble 2–3μ in diameter suddenly appears and rapidly enlarges. With further drying, as well as the enlargement of the bubble, the spore itself caves in to some extent. The separation of a gas phase seems to be an invariable concomitant of drying. It is easy to show that dry spores containing gas bubbles are fully capable of germination when placed in a suitable solution.

Exactly the same behaviour has been seen in ascospores of *Pleurage curvicolla* (Fig. 1) and *Hypoxylon fuscum*.

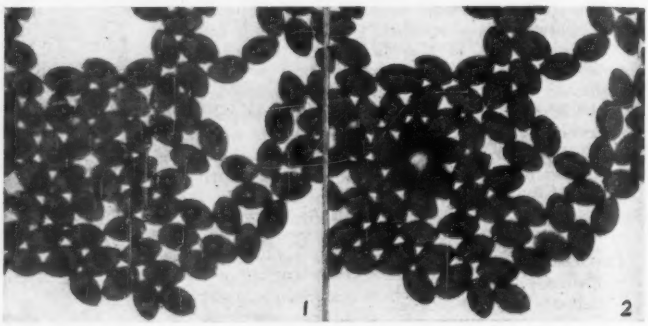


Fig. 1. (1) Freshly discharged spores of *Pleurage curvicolla* caught on a dry slide and photographed 15–20 sec. after flooding with water; each contains a gas-bubble. (2) The same spores 60 sec. later; the gas phase has disappeared. × 420

It seems likely that the gas bubble originates within the spore just as it does during spore discharge in the annulus cell of a drying fern sporangium or in the elater of a leafy liverwort. That is to say, as evaporation proceeds, the volume of the spore tends to be reduced; but this reduction is resisted by the rigidity of the cell wall, so that the aqueous contents pass into a state of tension which increases until a point is reached when rupture occurs and a gas phase, presumably water vapour, suddenly appears. That the bubble is water vapour is supported by the fact of its rapid disappearance when the spore is placed in water.

The gas phase can also be produced in *Sordaria* spores by dehydrating with glycerol. This can easily be observed if a small drop of water containing spores on a microscope slide is mixed with a larger drop of pure glycerol. A gas phase separates in most of the spores, although some simply collapse.

The sudden separation of a gas bubble on drying might be expected to produce a movement of the whole spore; but no such movement is seen in *Sordaria*, possibly because the spore is so firmly glued to the microscope slide by its sheath of mucilage.

There does not seem to be any biological significance in the occurrence of a gas phase in ascospores. If, however, the separation of gas in plant cells without loss of viability is at all general, it may be important. Thus, if a gas phase were suddenly to appear on drying in a spore finely perched on a conidiophore, the jolt

might well be enough to discharge it into the air. Possibly the temporary appearance of gas in living plant cells with rather rigid walls may be of common occurrence; in hard-leaved xerophytes, for example. However, since the gas would very quickly disappear in sections mounted in water, it would not normally be observed.

So far as I know, the pseudovacuoles of some blue-green algae are the only previously recorded examples of a gas phase in living plant cells.

C. T. Ingold

Birkbeck College,
London, W.C.1.
April 26.

Septate Fibres in Angiosperms and their Length

Recently, Govindarajalu and Swamy[1] have reported that the septate fibres are longer than the non-septate fibres in the secondary xylem of *Pithecolobium dulce* Benth. Since this is the first record of the difference between the length of septate and non-septate fibres in a wood, one is likely to get the impression that what has been found in *P. dulce* is true for all the Dicotyledons; but this is not so. In the course of our investigation, during the past five years, on septate fibres of Angiosperms, we find that in a large number of species there is little difference in length of these two types of fibres. Only in a few cases are septate fibres found to be either shorter or longer than non-septate fibres (Table 1).

In *Dendrocalamus strictus* Nees of the Gramineae, septate fibres occur both in the xylem and the phloem caps. Preliminary examination shows considerable difference between the length of septate and non-septate fibres found in the vascular bundles of the periphery and those of the interior (Fig. 1). Towards the interior the septate fibres are shorter than the non-septate fibres, whereas in the periphery they are longer.

Table 1. Length of Septate and Non-septate Fibres in Angiosperms

Family	Species	Mean length in mm.* Septate fibres	Non-septate fibres
Anacardiaceae	*Dracontomelum mangiferum* Blume	1·32	1·34
Bignoniaceae	*Heterophragma sulfureum* Kurz	1·22	1·23
Celastraceae	*Celastrus spinosa* Royle	0·54	0·73
Combretaceae	*Terminalia tomentosa* W. and A.	1·37	1·36
Elaeocarpaceae	*Elaeocarpus serratus* Linn.	1·53	1·47
	Elaeocarpus simplex Kurz	1·40	1·49
Lauraceae	*Cinnamomum glanduliferum* Meissn.	1·34	1·50
	Machilus fruticosa Kurz	1·33	1·58
Leguminosae	*Albizzia lebbeck* (L.) Benth.	1·17	1·19
	Peltophorum ferrugineum Benth.	1·16	1·10
	Pithecellobium dulce Bth. (Syn. *Pithecolobium dulce* Benth.)	0·80	0·55
	Samanea saman (Jacq.) Merr.	1·22	1·19
Lythraceae	*Lagerstroemia speciosa* (L.) Pers.	1·11	1·08
Meliaceae	*Swietenia mahagoni* Linn.	1·10	1·02
Myristicaceae	*Myristica angustifolia* Roxb.	1·14	1·07
Oleaceae	*Ligustrum compactum* Hook. f. and Th.	0·89	0·92
Punicaceae	*Punica granatum* Linn.	0·57	0·57

* Based on more than 150 measurements.

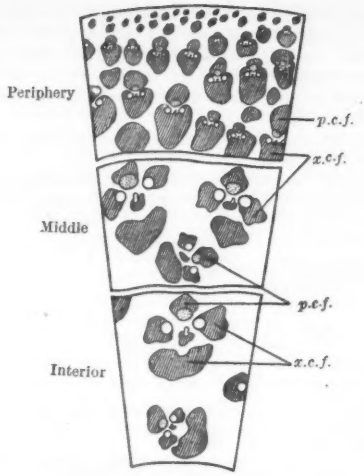
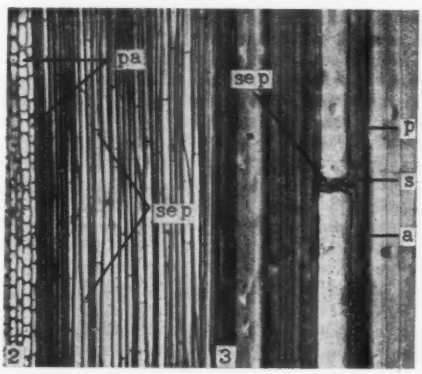


Fig. 1. *Dendrocalamus strictus* Nees, transverse section, internode, in part; *p.c.f.*, phloem cap fibres; *x.c.f.*, xylem cap fibres (× 15, diagrammatic)

Vestal and Vestal[2] first demonstrated the development of septate fibres in *Hypericum androsaemum* Linn. Purkayastha has worked out the development of septate fibres in some tropical trees. In the course of his investigation he has found that some crystalliferous fibres are related to septate fibres[3]. Again, Chowdhury has reported that in some genera there is little effect of environment on the frequency of occurrence of septate fibres, whereas in others, formation of septate fibres varies from locality to locality[4]. Recently, our work on bamboo (*Dendrocalamus strictus* Nees) has shown that the protoplasts in these fibres mostly live for a long time, often even after laying down the secondary wall (Fig. 2). Occasionally an additional layer is also deposited both on the vertical wall as well as on the septum. As a result, the septum is quite thick and consists of three distinct layers (Fig. 3).

The function of the septate fibres is at present not clearly understood. To say that the special function



D. strictus Nees, longitudinal section, internode. Fig. 2. *pa*, parenchyma; *sep*, septa (× 60). Fig. 3. *p*, primary wall; *s*, secondary wall; *a*, additional layer; *sep*, septum (× 500)

of the septate fibre is to give mechanical strength and serve for storage of food material is not quite correct[5]. In tropical woods, non-septate and septate fibres, and even vessels, have been observed to serve as storage tissues in living trees (Chowdhury, K. A., unpublished work).

A detailed account of this investigation will be published elsewhere.

K. A. Chowdhury
S. K. Purkayastha
S. S. Ghosh
J. S. Sond

Forest Research Institute,
Dehra Dun,
India.
Jan. 17.

[1] Govindarajalu, E., and Swamy, B. G. L., *Nature*, **176**, 315 (1955).
[2] Vestal, P. A., and Vestal, M. R., *Bot. Museum Leaflet, Harvard Univ.*, **8**, 16 (1940).
[3] Purkayastha, S. K., Proc. 40th Ind. Sci. Congr. (Abstracts), 98 (1953).
[4] Chowdhury, K. A., *J. Ind. Bot. Soc.*, **33**, 1 (1954); Proc. 8th Int. Bot. Congr. (in the press).
[5] Harrar, E. S., *Tropical Woods*, **85**, 1 (1946). Spackman, W., and Swamy, B. G. L., *Amer. J. Bot.*, **36**, 804 (1949).

Effect of Hormone Herbicides on the Growth of *Rhizobium trifolii*

In view of the widespread use of hormone-type herbicides on mixed stands of crop plants containing clover as an essential constituent, it would appear to be of considerable importance to determine the effect of these substances on the growth of the clover nodule-forming organism. This is particularly true of the phenoxybutyric compounds which have been recommended for use as herbicides where clover is present, since they have been shown by Wain[1] and other workers to have no harmful effect on clover due to the latter's lack of the β-oxidizing enzyme system.

The substances investigated in this experiment were the sodium salts of 24*D* (2 : 4 dichlorophenoxyacetic acid), *M.C.P.A.* (2-methyl-4-chlorophenoxyacetic acid), 245*T* (2 : 4 : 5-trichlorophenoxyacetic acid), 24*DB* (γ-(2 : 4-dichlorophenoxy)butyric acid), and *M.C.P.B.* (γ-(2 methyl-4-chlorophenoxy)butyric acid). They were incorporated in a yeast–mannitol agar[2] in the appropriate concentration of acid equivalent. Two agar plates were prepared for each concentration. A standard suspension of a known effective strain of rhizobium (*Rh. trifolii* 157) was prepared in sterile distilled water and three loopfuls were streaked on each Petri dish of agar. The plates were incubated at 24° C. for four days.

From the results it is clear that the herbicides had no effect on the growth of *Rhizobium trifolii* at concentrations up to 25 p.p.m. Beyond this level, the growth was moderate to poor up to 500 p.p.m. The bacteriostatic point lies beyond 500 p.p.m. but has not yet been determined. It will be noted that the butyric-acid compounds 24*DB* and *M.C.P.B.* were slightly less toxic than the acetic-acid compounds 24*D*, *M.C.P.A.*, and 245*T*.

Table 1

Substance / Conc. p.p.m.*	24*D*	*M.C.P.A.*	245*T*	*M.C.P.B.*	24*DB*
0	+++	+++	+++	+++	+++
1·0	+++	+++	+++	+++	+++
5·0	+++	+++	+++	+++	+++
25·0	+++	+++	+++	+++	+++
50·0	++	++	++	+++	++
100·0	+	+	+	++	++
200·0	+	+	+	++	++
300·0	+	+	+	+	+
400·0	+	+	+	+	+
500·0	+	+	+	+	+

* Acid equivalent. + poor growth; ++ moderate growth; +++ good growth.

Relating these figures to soil conditions, 1 acre of topsoil to 8–9 in. depth contains approximately 3 million pounds of moist soil. This refers to 'mineral' soil with about 3–12 per cent of organic matter. A convenient figure for the weight of topsoil of an arable field to the deliberately vague specification of 'plough depth' would be 2¼ million pounds or 1,000 tons. If the actual content of active growth substance in an application, on reaching the soil, is as much as 1 lb., the momentary concentration in the topsoil (assuming even distribution) is 0·5 p.p.m. approximately.

These are the concentrations over the whole mass of soil. But the substance is effective against plants or microbes only to the extent that it dissolves in the soil water. Assuming no adsorption but complete solution, and a 20 per cent water content of soil, the concentrations become 2–2·5 p.p.m. = 1 lb./acre approximately. Since the growth of *Rhizobium trifolii* is unaffected by concentrations up to 25 p.p.m. (= 10 lb./acre), it can be assumed that the concentrations used in agricultural practice (usually 1 lb. of the acid equivalent per acre) will have no adverse effect on the growth of *Rhizobium trifolii* even assuming that all of it reaches the soil.

Thanks are due to Messrs. May and Baker, Ltd., for supplying the *M.C.P.B.* and 24*DB* for experimental purposes.

Wm. W. Fletcher
West of Scotland Agricultural College,
Blythswood Square,
Glasgow, C.2,
May 4.

[1] Wain, R. L., *Agric. Rev.*, 1 (1955).
[2] Fred, E. B., Baldwin, I. L., and McCoy, E., "Root Nodule Bacteria and Leguminous Plants" (Madison, 1932).

Growth of Lettuce Seedlings

The methods of growth analysis[1] have been applied to comparatively few horticultural crops; yet, as stated by Gregory at the Thirteenth International Horticultural Congress in 1952 [2], these techniques open up a wide field in horticultural research and are an essential basis of any attempt to understand the control of growth by environmental factors.

The following results were obtained with lettuce (*Lactuca sativa*, Linn.), variety Cheshunt 5*b*, during the course of an investigation of the rate of recovery of seedlings from the check of transplanting, full results of which will be reported elsewhere. The study was confined to the first three or four weeks of growth; that is, up to or beyond the normal stage for planting out. Plants were raised at various seasons in growth rooms and also during mid-winter in a heated glasshouse. In the growth rooms, plants were grown at constant temperatures of 70°, 60° and 50° F., day-lengths of 16 and 9 hr., and light intensities, at plant-level, of approximately 650, 400 and 250 ft. candles, using fluorescent daylight tubes. Net assimilation-rates were obtained by the usual formula[3], leaf areas being calculated from length and breadth measurements, excluding the petiole. Good

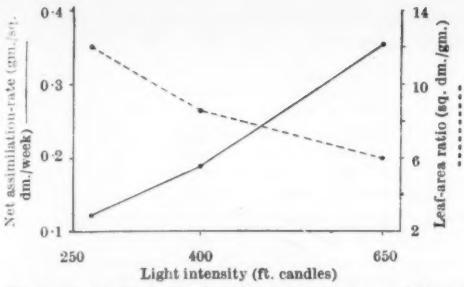


Fig. 1. Temperature, 70° F.; day-length, 16 hr.; period, 14–23 days from germination

correlation was obtained between actual leaf area and the products of length and breadth measurements when determined in small samples.

Net assimilation-rate varied with environmental conditions, values ranging from 0·06 gm. per sq. dm. per week, under natural light in a glasshouse in mid-winter (temperature-range 50–60° F.), to 0·35 at 70° F. with 16-hr. days and a light intensity of approximately 650 ft. candles. As found by Blackman and Wilson for several species[4], net assimilation-rate increased with light-intensity over the range tested (Fig. 1). Higher net assimilation-rates were recorded in long than in short days; but a negative relationship was indicated between temperature and net assimilation-rate (Table 1).

Table 1

Day-length: 16 hr. Light-intensity: 400 ft. candles

	70° F.	60° F.	50° F.	S.E.
Mean net assimilation-rate during first four weeks of growth	0·145	0·174	0·197	± 0·0077

Leaf area ratios, on the other hand, were significantly increased at higher temperatures, but decreased at higher light-intensities. Fig. 1 illustrates the relationship between light intensity, net assimilation-rate and leaf-area ratio, and effects of temperature and light-intensity on leaf-area ratio are shown in Table 2.

Table 2

Day-length: 16 hr. 14–23 days from germination

Temperature (° F.)	Light intensity (ft. candles)	Leaf-area ratio (sq.dm./gm.)
70	650	6
50	400	6
70	400	9
70	250	12

Abundant water was made available to all plants by means of a system of constant sub-irrigation. Conditions of high temperature and low light-intensity, which induced high leaf-area ratios and low net assimilation-rates, were accompanied by increased moisture content, as shown by the ratios of wet to dry weights.

Relative growth-rate is the product of net assimilation-rate and leaf-area ratio. Plants grown at the lowest light-intensity had a low net assimilation-rate, but a high leaf-area ratio which, to some extent, had a compensatory effect on relative growth-rate. Values of relative growth-rate ranged from 0·09 to 0·32 gm. per gm. dry weight per day, and it is believed that the latter is the most rapid rate of growth recorded for a crop plant. Rapid growth-rates do not necessarily produce the best type of plant, since this is dependent on a suitable balance between leaf-area ratio and net assimilation-rate. For example, plants with high leaf-area ratios had long petioles and the leaves were thin and soft in texture.

These results emphasize the importance of maintaining a suitable balance between temperature and light-intensity for satisfactory growth. This applies particularly to the culture of plants in glasshouses during winter, when light-intensity is low and where high temperatures cannot compensate for lack of light.

Growth analysis provides a means of examining and evaluating the effects of horticultural practices. The present investigation has clearly shown that severe reduction of the root or shoot during transplanting at the cotyledon stage checks growth, but that the effect is temporary. Under good growing conditions, the shoot/root ratio, net assimilation-rate, leaf-area ratio and relative growth-rate rapidly reassume values comparable with those of an uninjured plant. Lettuce seedlings showed considerable modification in their habit of growth under the conditions to which they were subjected in these experiments.

WINIFRED M. DULLFORCE

Department of Horticulture,
University of Nottingham School of Agriculture,
Sutton Bonington.
Feb. 7.

[1] Briggs, G. E., Kidd, F., and West, C., *Ann. App. Biol.*, **7**, 103, 202 (1920). Gregory, F. G., *Ann. Bot.*, **40**, 1 (1926).
[2] Gregory, F. G., Rep. 13th Int. Hort. Congr., 96 (1953).
[3] Watson, D. J., *Advanc. Agron.*, **4**, 191 (1952).
[4] Blackman, G. E., and Wilson, G. L., *Ann. Bot.*, N.S., **15**, 63 (1951).

Soil Thermometers

FOR the measurement of soil temperatures at depths of 1 ft. or greater, it is established practice in many parts of the world to use a specially modified thermometer which is hung in a tube and withdrawn for reading. So that its indication will not change appreciably during the process of reading, the bulb is surrounded by a mass of paraffin wax to give it a high lag coefficient.

We have recently had occasion to check the calibration of a number of these thermometers and found that at 40° F. and below their indications were considerably in error. At 40° F., errors of between 1° and 2° F. were not uncommon, and at 20° F. the errors might be as large as 6° or even 8° F. In all cases the thermometers were reading high. The thermometers themselves, when removed from the wax, had negligible errors, that is, they were within the limits of accuracy laid down for this class of thermometer.

When the thermometers were subjected to an external hydrostatic pressure of several hundred pounds per square inch, the bulbs were reversibly deformed sufficiently to cause errors of the above magnitude. It is clear from this, and other tests, that the errors are caused by pressures developed on the bulbs by thermal contraction of the wax at low temperatures. The errors so caused are not repeatable and depend on the previous thermal history of the thermometer, presumably because of plastic flow in the wax.

Only thermometers of one maker have been checked; but since the trouble is due to a fundamental weakness in the design specification, the products of other makers using similar waxes will presumably be affected to a greater or lesser degree.

In view of the fact that thermometers of this design are fairly widely used, it was thought desirable to bring the situation to the notice of as wide a group of interested people as possible: particularly those interested in using these instruments for studying long-term trends in earth temperature.

Z. S. Garvitch
M. C. Probine

Microclimatology Section,
Dominion Physical Laboratory,
Lower Hutt,
New Zealand.
April 11.

Periodicity of the Laminariaceae around Scotland

During 1946–55, an extensive survey of the Laminariaceae growing around the coast of Scotland has been in continuous operation. The whole of the marine coast of Scotland—more than 6,000 miles—has been photographed (through the co-operation of the Royal Air Force) and, with the aid of these stereoscopic aerial photographs, quantitative assessments of the Laminariaceae have been made by using ecological factors which the data, collected from detailed sub-littoral surveys, have revealed[1].

Detailed surveying, using methods of quadrat sampling with calibrated spring grabs[2], was operated from boats on charter from the fishing fleet, during all times of the year.

Over sub-littoral areas of the north-east, north-west, south-east and south-west mainland of Scotland, the Orkney Islands and the Isle of Skye, eighty-six detailed surveys have been completed and analysed, and of these more than half have been re-surveys (for example, Girvan to Bennane, six times). This work has involved the measurement of 100,000 quadrats from more than 67,000 acres (27,000 hectares) of the sea bed.

It has been found that changes in the quantity as well as the ratio of species occurred over a number of years; it is now possible to indicate the trend. By far the greater quantity of the Laminariaceae was found above five fathoms (nine metres) and consisted of *Laminaria cloustoni* Edm., *L. saccharina* Lamour and *L. digitata* Lamour. Based on all quadrat values obtained from eighty-six surveys, mean fresh weight per unit area of the three Laminariae, found between one and five fathoms, in each calendar year, from 1946 until 1955, was:

	lb./sq. yard (× 0·54 for kgm./sq. metre)		lb./sq. yard (× 0·54 for kgm./sq. metre)
1946	9·1	1951	5·4
1947	13·4	1952	3·7
1948	11·2	1953	2·8
1949	8·0	1954	3·4
1950	5·0	1955	4·7

These values when plotted logarithmically show the trend over the past ten years (Fig. 1).

Extrapolation of the graph backwards in time gives a trough in 1942 of the same level as 1953; and forwards in time gives a crest in 1958 of the same level as 1947. Ecological factors combining to produce an eleven-year cycle would appear to be controlling the reproduction, colonization and growth of the Laminariaceae around Scotland.

Mention of an eleven-year cycle brings to mind sunspot activity. The annual mean of monthly sunspot numbers, published by the Federal Observatory, Zurich, have also been plotted in Fig. 1. The Royal Greenwich Observatory finds there is a satisfactory parallelism between these mean sunspot numbers and the sunspot areas which they measure. It will be seen that the two graphs show a surprising degree of correlation.

The laminarian periodicity is not thought to be the direct consequence of sunspot activity, but rather the indirect result of such activity producing meteorological conditions which in turn are reflected in the marine environment.

I wish to thank Mr. W. H. Newton, of the Royal Greenwich Observatory, for supplying the information on sunspot activity.

F. T. Walker

Institute of Seaweed Research,
Musselburgh,
Midlothian.
Feb. 17.

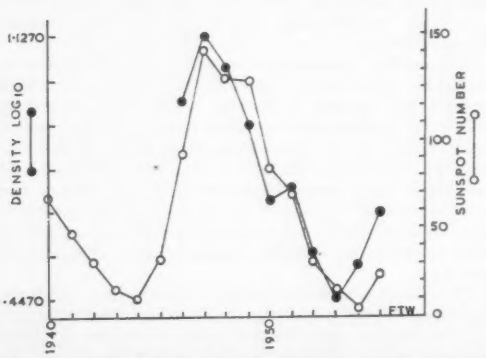


Fig. 1. Relationship of the fresh weight of Laminariaceae and the frequency of sunspots

[1] Walker, F. T., *J. Conseil explor. Mer*, **20**, 160 (1954).
[2] Walker, F. T., *J. Ecol.*, **35**, 66 (1947).

A Marlin in Angola, with a Note on *Makaira herschelii* (Gray), 1838

Marlin fishes of the genus *Makaira* Lacépède, 1801, in which the dorsal fin is lower than the body, are found over wide areas of the three main oceans in a broad equatorial belt, mostly within the 20° isotherms. In the Atlantic proper there has so far been found only the so-called 'blue' marlin, generally named *Makaira ampla* (Poey), 1860. This fish, doubtfully distinct by full specific rank from the Indo-Pacific 'black' marlin, *M. herschelii* (Gray), 1838, is said to occur also in the Pacific. In the Atlantic, the blue marlin has been recorded in scientific literature chiefly from the region of the West Indies, and from the north-western coastal areas of South America. It has also been reported from off south-western Europe, and from St. Helena (lat. 16° S., long. 5° 40′ W.) in the south Atlantic. The other smaller marlin of the Atlantic, and confined to that ocean, *Lamontella*[1] *albida* (Poey), 1860, has a somewhat similar but less extensive distribution than *M. ampla*, while the 'mystery' marlin, *Orthocraeros*[1] *bermudae* (Mowbray), 1931, is known from only one specimen, photographed but regrettably destroyed.

As marlins are known to travel widely, it is astonishing to find that the range of these fishes in the Atlantic is far more restricted than might be supposed. Up to the present, there has not appeared in scientific literature any report of the occurrence of any species of marlin anywhere near the whole length of the extensive western coast of Africa. Colonel J. K. Howard, of Miami, has informed me privately that he caught a marlin (unspecified) at Cape Verde, and that natives told him that marlins had been seen off Accra, Gold Coast (4° N.); but no confirmatory evidence is available.

What is remarkable is that I cannot find any evidence of a single marlin of any kind having ever been reported from a vast area of the Atlantic, extending north-west from the Cape, bordered on the east by the west coast of Africa, and including the enormous area of the Gulf of Guinea. This is certainly an astonishing gap, for it is an area with notable concentrations of the comparable tunny fishes, where marlins might well be expected to occur and even to abound.

Partly as a result of the publicity attending recent marlin discoveries in South African seas, a considerable amount of interesting information has reached me. One item is a photograph of a large marlin thrown ashore at Lobito Bay, Angola (lat. 12° 30′ S., long. 13° 10′ E.). The fish had been damaged by sharks and from the photograph was patently putrescent; but it certainly falls in *Makaira* Lacépède, and is thus the first marlin ever to be reported in the eastern Atlantic area defined above. No dimensions of any kind were apparently taken of the fish itself, but the photograph contains sufficient detail to enable the principal dimensions to be estimated, and by careful compilation and deduction these would have been very close to the following: total length, 144 in.; standard length, 124 in.; depth of body, 22 in.; height of dorsal lobe, 17 in.; suprapectoral height, 17 in.; length of head, 42 in.; spear before eye, 28 in.; tip of spear to tip of lower jaw, 15 in.; estimated weight, about 450 lb.

This information alone does not clearly settle the identity of the fish as a 'black' or a 'blue' marlin, though the relatively elevated dorsal lobe indicates 'blue'. On the other hand, that fin in this case falls within the upper limit recorded for the 'black', while the relatively short stout spear is more characteristic of the latter fish.

The discovery of this fish at Lobito opens up several interesting possibilities. It may have been a black marlin, the presence of which in the Atlantic I have long suspected. Also this Lobito fish does not necessarily indicate that marlin are abundant along the west coast of Africa, for no others have been reported there and this may have been a stray. On the other hand, anglers in Angolan waters not infrequently have strong tackle ripped away by unknown monsters that might well be marlin, and careful search may reveal that they are normally present there.

The third undoubted marlin to be reported in scientific literature was *Tetrapturus herschelii* (Gray), 1838, based on an 11-ft. fish thrown up in Table Bay. Some American workers have suggested that *herschelii* was of Atlantic origin and hence of uncertain identity in relation to its position as the first valid type of the black marlin, which most name either *mazara* Jordan and Snyder, 1901, or *marlina* Jordan and Evermann, 1926.

Although nominally on the border of the Atlantic Ocean, the Cape is, faunistically, almost completely isolated from the Atlantic by the wide belt of cold water that lies along the coast of South-West Africa. Because of the powerful westward warm Mozambique Current, the Cape is indeed connected far more closely with the tropical Indian Ocean than with any comparable even much closer area of the Atlantic. There is little doubt that *herschelii* travelled westwards with that current to and beyond Agulhas, where it was doubtless killed by the cold water. A comparable marlin was recently found floating dead in False Bay, Cape, and I have been sent a photograph, faded, but amply clear, of an approximately 10-ft. undoubted 'black' marlin found in Table Bay in 1923.

The original description and figure of *herschelii* accord quite satisfactorily with all marlins of comparable size found in southern Africa at and eastwards of the Cape, all of them 'black' marlins, apparently identical with those found in the Pacific and Indian Oceans. Among numerous specimens in South and East African waters, ranging from 45 to 450 lb. in weight, I have not yet found a single undoubted 'blue' marlin.

There is thus little doubt that if the 'black' marlin be accorded full specific distinction from the 'blue', it should bear the name *Makaira herschelii* (Gray), 1838. This adds another to the long list of fishes first found at the Cape and later discovered over wide areas of the globe.

J. L. B. Smith*

Rhodes University,
Grahamstown,
South Africa.
April 19.

* S.A. Council for Scientific and Industrial Research Fellow in Ichthyology.

[1] See Smith, Dept. Ichthy. Rhodes Univ. Bull. 2 (1956).

Death of Flamingoes in the Camargue

The sudden onset of cold weather in the Camargue during February of this year is reported to have killed off the wintering colony of flamingoes, *Phoenicopterus ruber roseus* Pall. There were said to be between 3,000 and 4,000 birds in the region. On a tour of the area during April 29–May 4, I saw at least 1,000 birds either in the air or settled around what appeared to be two nesting sites on the extreme eastern and western flanks of the Reserve. Mr. Luc Hoffmann, director of a private research station at Tour du Valat, is of the opinion that about 3,000 nests were occupied at the end of May. Nevertheless, he considers that probably 2,000 and possibly 3,000 birds perished earlier. He says he counted 200 dead birds in a very restricted area, and it may be significant that more than half of them were immature. Some birds tried to emigrate when the temperature began to fall; frozen corpses were found about 100 km. to the west of the Reserve; but a few partly frozen birds, recovered near his laboratory, were revived by warmth. Apparently no specific cause of the death of the birds can yet be given. One local observer said the legs of the flamingoes froze in contorted positions in mid-air. However, the present breeding stock is reported to be rather more than a good average.

John Hillaby

85 Cholmley Gardens,
London, N.W.6.
June 3.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, July 3

UNIVERSITY COLLEGE, LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. D. A. Denton (University of Melbourne): "Regulation of Sodium Ion Content in Sheep with Parotid Fistulae".*

Tuesday, July 3—Friday, July 6

INSTITUTE OF PHYSICS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2)—Conference on "The Physics of Nuclear Reactors".

Wednesday, July 4

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. R. W. Riddell: "Mycology".* (Further lectures on July 18 and 25.)

Friday, July 6

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 425, Birkbeck College, Malet Street, London, W.C.1), at 6 p.m.—Dr. C. Sofer: "Possible Contributions of Social Science to Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GUIDE LECTURER at the Geological Museum, London, S.W.7, for duties which include giving lectures and lecture-demonstrations to the general public—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.4601/56/7 (July 4).

SHELL B.P. RESEARCH FELLOW IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING—The Secretary and Registrar, The University, Southampton (July 4).

RESEARCH ASSISTANT (with research experience in biochemistry or the chemistry of natural products) IN CHEMICAL MICROBIOLOGY IN THE DEPARTMENT OF BOTANY—The Secretary, University College, Gower Street, London, W.C.1 (July 11).

ANALYTICAL CHEMIST (with a degree or higher national certificate in chemistry) mainly for plant material—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 14).

ASSISTANT LECTURER or LECTURER IN ELECTRICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (July 16).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHILOSOPHY—The Registrar, The University, Manchester (July 21).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Reading (July 21).

ASSISTANT LECTURER IN GEOLOGY—The Registrar (Room 9 O.R.B.), The University, Reading (July 23).

LECTURER IN ZOOLOGY; LECTURER IN MATHEMATICS; and a LECTURER IN PHYSICS, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 15).

CHAIR OF MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (August 31).

SENIOR LECTURER IN BIOCHEMISTRY at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 31).

ASSISTANT CONSERVATOR OF FORESTS, CLASS 1 (with a university degree in forestry and experience of teaching foresters) to administer the Forestry College at Prodromos, Cyprus, and to be responsible for the teaching of its syllabus—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD. 61/17/07.

LABORATORY TECHNICIAN (preferably with some photographic experience) IN THE DEPARTMENT OF PHYSICS to assist in radiation protection investigations—The House Governor, Royal Marsden Hospital, Fulham Road, London, S.W.3.

LABORATORY TECHNICIANS (with experience in research procedures including histology and laboratory animal dissection)—The Chief Technician, Clinico-Pathological Laboratories, Imperial Cancer Research Fund, Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2.

LECTURER or GRADE B ASSISTANT IN INORGANIC CHEMISTRY; and a GRADE B ASSISTANT IN ORGANIC CHEMISTRY at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

LECTURER (preferably with special interests in entomology, physiology or protozoology) IN ZOOLOGY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

ORGANIC CHEMIST (with a degree in chemistry or biochemistry and postgraduate laboratory or research experience) to work at the Low Temperature Research Station, Cambridge, on the chromatographic analysis of potatoes in relation to blackening—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

RESEARCH ASSISTANT (graduate in physics, engineering or mathematics, the latter with laboratory experience) for experimental work on the flow of stratified fluids—The Meteorology Department, Imperial College, London, S.W.7.

RESEARCH ASSISTANTS (2) (with a suitable degree or equivalent qualification) in (a) CHEMISTRY OR BIOLOGY; or (b) TELECOMMUNICATIONS OR PHYSICS—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27.

RESEARCH SCHOLAR IN THE DEPARTMENT OF TEXTILE CHEMISTRY—The Registrar, College of Technology, Manchester 1.

SCIENTIFIC ASSISTANT (graduate, with proficiency in reading and abstracting foreign biological literature), and a SCIENTIFIC ASSISTANT (graduate in zoology, with experience in handling taxonomic problems and proficiency in reading foreign helminthological literature)—Prof. R. T. Leiper, Commonwealth Bureau of Helminthology, The White House, 103 St. Peter's Street, St. Albans, Herts.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering or physics, and preferably with an interest in applied mechanics and thermodynamics) to work on wheel research and testing of crop driers—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.

SENIOR PLANT PHYSIOLOGIST, PRINCIPAL SCIENTIFIC OFFICER GRADE (with a special knowledge and research experience of plant physiology) to develop a Physiology Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick.

SOIL SURVEY OFFICER (with a good second-class honours degree in natural science, geography or agriculture) IN THE DEPARTMENT OF SOIL AND LAND USE SURVEY, Gold Coast, to supervise the field work of the survey, assist in the compilation of soil survey reports and maps, and assist in the training of junior staff—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.79/13/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Cancer Research Fund. Fifty-third Annual Report, February–November, 1955. Pp. 44. (London: Imperial Cancer Research Fund, Royal College of Surgeons, 1956.) [274

Report of the Committee appointed to review the Provincial and Local Organisation and Procedures of the Ministry of Agriculture, Fisheries and Food. Pp. vi+108. (Cmd. 9732.) (London: H.M. Stationery Office, 1956.) 4*s.* 6*d.* net. [274

National Smoke Abatement Society. Year Book, 1956. Pp. 64. (London: National Smoke Abatement Society, 1956.) 1*s.* [274

Grassland Research Institute. Memoir No. 1: Lucerne Investigations, 1944–1953. Pp. ii+81+2 plates. (Hurley, near Maidenhead: Grassland Research Institute, 1955.) 10*s.* [274

British Electrical and Allied Industries Research Association. Thirty-Fifth Annual Report (1st January, 1955 to 31st December, 1955.) Pp. 141. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) [274

Other Countries

Bulletin of the American Museum of Natural History. Vol. 108, Article 4: Cretaceous System in Northern Peru. By Victor E. Benavides-Cáceres. Pp. 353–494+plates 31–66. (New York: American Museum of Natural History, 1956.) 3.50 dollars. [244

Comité International des Poids et Mesures. Procès-Verbeaux des Séances, Session de 1954 (28 Septembre–14 Octobre); et Sessions des Comités Consultatifs—Définition du Mètre (1953)—Thernométrie (1954). (Deuxième Série—Tome 24.) Pp. iii+480+iii. (Paris: Gauthier-Villars, 1955.) [274

International Nickel Company of Canada Limited. Address to Shareholders, Annual Meeting, April 25, 1956. Pp. ii+21. (Toronto: International Nickel Company of Canada Limited, 1956.) [274

Cawthron Institute. Lecture Series No. 30: The Production and Maintenance of Soil Tilth. By Dr. E. W. Russell. Pp. 20. (Nelson, N.Z.: Cawthron Institute, 1955.) [274

Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Divisions and Sections as at 1st January 1956. Pp. 17. List of Publications to December, 1955. Pp. 36. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [274

Report of the Thirty-First Meeting of the Australian and New Zealand Association for the Advancement of Science (Melbourne, August, 1955). Part 1. (*Australian Journal of Science*, Vol. 18, No. 3A, January, 1956.) Pp. 48+xvi. (Sydney: Fairway Publications Pty, Ltd., 1956. Published on behalf of The A.N.Z.A.A.S. Publications Committee.) [274

Sudan Government: Ministry of Agriculture. Bulletin No. 16: The Insect Pests of Vegetables in the Sudan. By D. G. Pollard. Pp. 72 (7 plates). (Khartoum: Ministry of Agriculture, 1955.) 40 P.T. [15

Directory of Aluminium, 1955. Pp. xvi+65. (Bangalore: India Section, Electrochemical Society, Inc.; Indian Institute of Science, 1956.) [15

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office